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STUDIES ON ABNORMAL ARTERIOVENOUS COMMUNICATIONS, ACQUIRED AND CONGENITAL

I. REPORT OF A SERIES OF CASES

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The subject of abnormal arteriovenous communications is so large that it seems inadvisable to discuss it in one paper; therefore I shall attempt to present it in a series of papers including: (1) a report of cases; (2) the origin and nature of arteriovenous aneurysms, cirsoid aneurysms and simple angiomas; (3) the effects of arteriovenous aneurysms on the heart and blood vessels and other structures, and (4) the treatment of arteriovenous and cirsoid aneurysms.

The material for these papers is derived mainly from a study of the author's own cases of arteriovenous communications and from experimental work done in the laboratories of the Johns Hopkins University and the University of Cincinnati. It is further supplemented by a careful study of all the cases recorded in the Johns Hopkins Hospital and by an extensive study of the literature on the subjects of arteriovenous aneurysms, cirsoid aneurysms, racemose aneurysms, aneurysms by anastomosis, pulsating angiomas and, to a lesser extent, angiomas.

My purpose is to present and discuss certain interesting observations on the subject of arteriovenous lesions, observations which have led to numerous experimental problems in the laboratory and to a search of the literature for similar observations made by others. These studies have forced me to adopt some ideas about vascular conditions that are not generally accepted, and it has therefore been particularly gratifying whenever I have chanced to find similar views expressed by others.

In these articles, the term abnormal arteriovenous communications will be used to include arteriovenous aneurysms, cirsoid aneurysms (racemose aneurysms, aneurysms by anastomosis), pulsating angiomas and possibly simple angiomas, for I believe that there are no essential differences between them. They are all probably instances of abnormal arteriovenous communications. If they are, then the term arteriovenous aneurysm is all embracing; for, by definition, it is "any abnormal communication established between the arterial and venous channels" (Matas). The medical profession, however, has come to regard

arteriovenous aneurysms as having to do with trunk line vessels and not with the very small arteries and veins. For instance, the condition that results when a blow on the head establishes a free communication between the vessels of the scalp is known as a cirsoid aneurysm and not as an arteriovenous aneurysm. Reasons for these beliefs will be fully discussed in subsequent papers. They are simply stated here in order to make the presentation of cases intelligible to the reader.

There is a very extensive literature on the subjects of arteriovenous aneurysms, cirsoid aneurysms and angiomas. As the purpose of this paper is to deal with certain aspects of these conditions, I will give references only to those authors quoted. For good general articles on the subject of arteriovenous aneurysm, the reader is referred to those of Matas, Callander,[1] Makins,[2] Monod and Vanverts,[3] and Bramann,[4] for the subject of cirsoid to those of Stich and Fromme.[5]

ACQUIRED ABNORMAL ARTERIOVENOUS COMMUNICATIONS

In this group are twenty-seven cases. Only those cases most carefully studied and most illustrative of points to be discussed in subsequent papers are reported in full, the others are reported in the tables.

CASE 10.[6]—A colored man, aged 48, was admitted to the Johns Hopkins Hospital Oct. 13, 1916, with a long standing arteriovenous aneurysm of the right leg. The fistula was in Hunter's canal opposite a small cutaneous scar of unknown origin and duration. The history and physical signs indicated that the fistula had been present for probably over thirty years. The leg was darkly pigmented and presented an ulcer on the shin. The artery was dilated from the fistula back to the heart and below Poupart's ligament was very tortuous. The heart was enlarged, extending 13 cm. to the left of the midline and 4 cm. to the right. There was a wide area of retrosternal dulness. At the apex was a loud systolic murmur. The pulse was felt in the right dorsalis pedis artery as easily as in the left. The legs were of equal length.

Studies by means of vascular tracings and the electrocardiogram gave the following results:

Jugular and Radial: Two extrasystoles without a full compensatory pause, probably nodal in origin. Similar premature contractions are seen in all the tracings obtained. The amplitude of the auricular waves is unusually great.

Jugulocarotid and Radial: Carotid element is prominent in this jugular tracing. Conduction time about 0.22 second. Rate, 62 per minute.

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1. Callander, C. L.: John Hopkins Hosp. Reports **19**:259, 1920.

2. Makins, G. H.: Gunshot Injuries of the Blood Vessels, New York, William Wood & Co., 1919.

3. Monod, C., and Vanverts, J.: Rev. de Chir. **42**:729, 1910.

4. Bramann, F.: Arch. f. klin. Chir. **33**:1, 1886.

5. Stich, R., and Fromme, A.: Ergebn. d. Chir. u. Orthop. **13**:144, 1921.

6. This case was previously reported by the author in a paper on "The Effect of Arteriovenous Fistula Upon the Heart and Blood Vessels," Bull. Johns Hopkins Hosp. **31**:43, 1920. It is again included because of the ultimate result.

Aex and Radial: The radial pulse follows the apex pulse by about 0.2 second.

Right Femoral: Premature contractions coming after each normal beat give a temporary bigeminal character to the pulse. The coarse thrill is indicated by fine oscillations in some portions of the tracing.

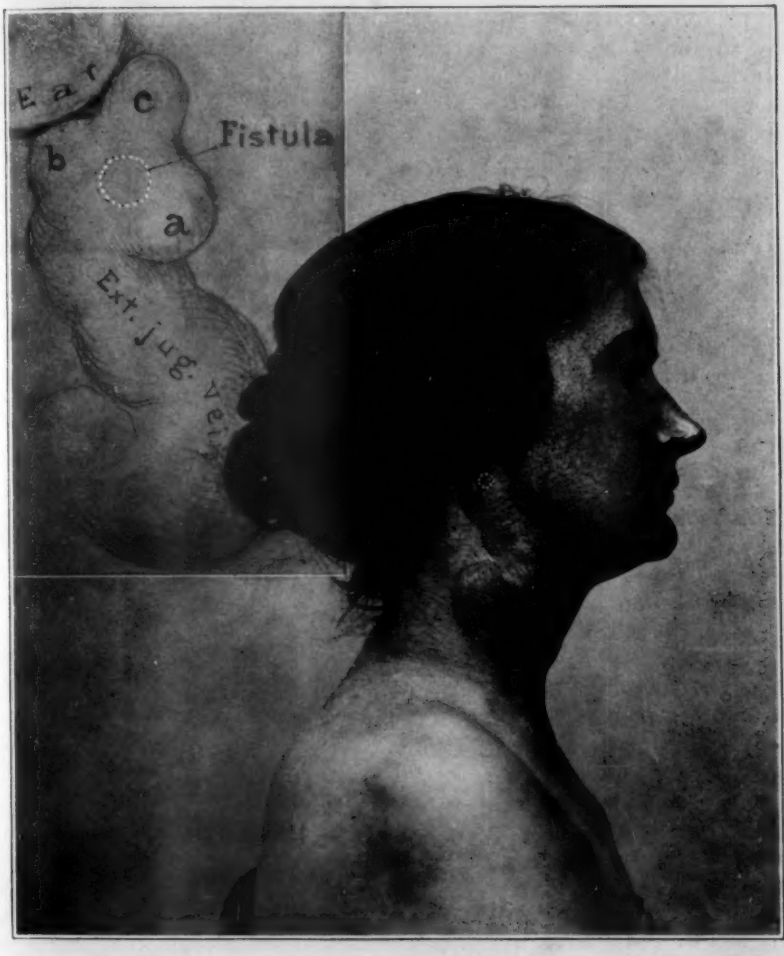

Fig. 1 (Case 14).—Arteriovenous aneurysm between the external carotid artery and external jugular vein. The condition was caused by a puncture wound with the point of a scissors when the patient was two years old. The fistula had been present thirty-two years, and the heart was enlarged. She was not conscious of the very loud bruit and strong thrill. The fistula was excised (Fig. 2.).

Right Femoral and Radial: Impulses from the radial artery and from the dilated femoral are synchronous in time.

Apex and Right Femoral: The impulse from the aneurysm follows the apical impulse by about 0.2 second.

Operation.—Operation was performed under a tourniquet Oct. 31, 1916, by Dr. Halsted. The fistula was divided, and the openings in the artery and vein were closed with silk, thus reestablishing the continuity of both vessels. The operation consumed several hours, and a few small clots of blood were occasionally observed in the blood that was expressed from the open vein.

During convalescence the patient had the very definite physical signs and symptoms of small pulmonary infarcts in the right lung. This complication, however, did not prove to be of any serious consequence. The wound healed by first intention, and the circulation in the foot remained good, the pulse in the dorsalis pedis not changing perceptibly in character. The blood pressures in both arms and legs remained about the same after the operation as before.

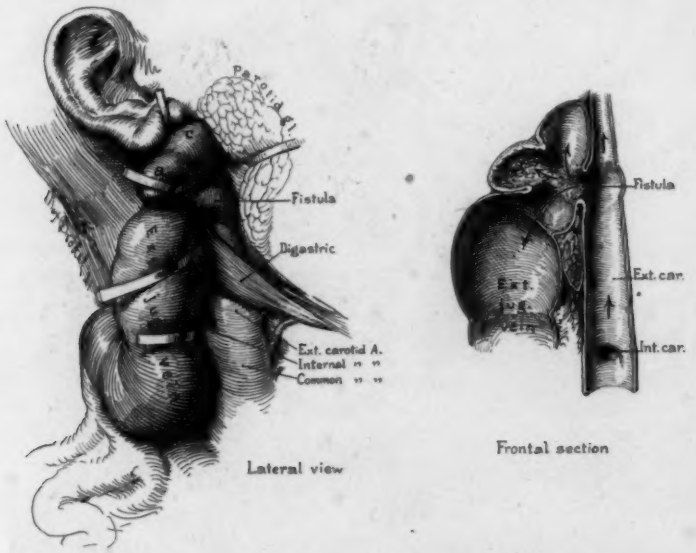

Fig. 2 (Case 14).—The duration of the fistula was thirty-two years. The calcification of the vein and the enlargement of the artery proximal to the fistula may be noted.

After leaving the hospital the patient disappeared from observation until Aug. 14, 1922, when he entered the Mercy Hospital in Baltimore under the care of Dr. McGlannan. At that time he had a moist gangrene extending to the right knee and a large, true aneurysm in Scarpa's triangle. On August 17, Dr. Evans amputated the leg through the lower part of the thigh, ligating the artery just below the aneurysm. The aneurysm continued to pulsate until the last week in September when the patient observed that it had stopped. On his return for examination October 4, the aneurysm had clotted and was represented by a firm mass in the thigh.

Case 14.—A woman, white, aged 34, was admitted to the Johns Hopkins Hospital June 15, 1920, with an arteriovenous aneurysm in the right side of her neck, the result of a puncture wound made at the age of 2. She did not recall having noticed a thrill or swelling before the age of 9. Throughout her life the main discomfort from the swelling in her neck had been the consciousness of its increasing size. She had never been aware of the very loud

noise caused by the fistula. Recently, she had had coughing spells associated with a sensation of pressure and tickling in her throat. There had been no symptoms referable to the heart; she sought relief because of the deformity in her neck.

The photograph (Fig. 1) shows the size of the dilated external jugular vein and its branches. The right common carotid artery appeared to be about twice as large as the left, and a very pronounced thrill was present. An extraordinarily loud bruit, with its greatest intensity over the fistulous opening, could be heard over the entire head and neck. The right tonsil was prominent

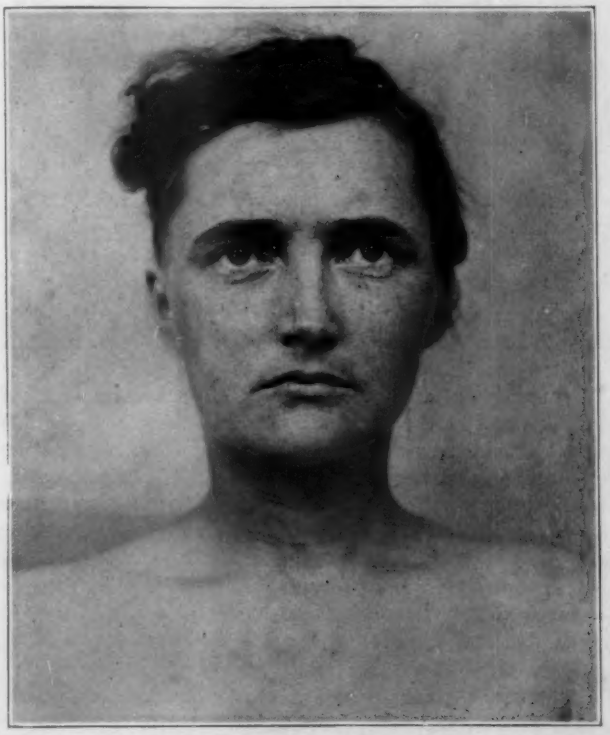

Fig. 3 (Case 14).—Two weeks after the complete excision of the arteriovenous fistula; the large pulsating veins noted in Figure 1 became invisible.

and both it and the anterior faucial pillar pulsated. By firm pressure just below the lobe of the ear one could occlude the fistulous opening and cause all signs of the aneurysm to disappear. The heart was enlarged, the apex impulse being felt well out in the axilla. The cardiac sounds were essentially clear. The roentgen-ray report, June 16, 1920, was: The left side of the heart was enlarged. The teleoroentgenogram showed: median left, 10.5; median right, 2; longitudinal, 18; transverse, 11. The electrocardiographic studies revealed a normal mechanism, and there was no evidence of ventricular preponderance. The Wassermann reaction was negative. The blood pressure in the right arm averaged: systolic, 110; diastolic, 65. In the left arm it was: systolic, 98; diastolic, 60. Studies of the blood and urine revealed nothing

abnormal. The volume of the right temporal pulse was about one-half as great as that of the left. The eye grounds were normal.

Operation.—Operation was performed June 23, 1920, by me (Fig. 2). The fistula was on a level with the middle of the parotid gland and formed a communication between the external carotid artery and the external jugular vein. The external carotid artery and its branches were enormously dilated. The external jugular vein was 3 cm. in diameter. The portions of the two vessels involved in the fistula were excised, silk being used for ligatures. Examination of the specimen showed the size of the fistulous opening to be 8 mm. vertically and 1 cm. transversely. The vein opposite the fistula was calcified. The arterial wall appeared to be normal.

There were no postoperative complications. For several days following the operation there was a pronounced bradycardia. The blood pressure on the second day after the operation was: systolic, 172; diastolic, 75 in each arm; this represented a marked rise in pressure compared with the preoperative pressures.

The teleoroentgenogram July 8, 1920 showed: median left, 9.5; median right, 1.5; longitudinal, 17.5, and transverse, 10.5. Oct. 15, 1920, these measurements were: median left, 9; median right, 2; longitudinal, 15, and transverse, 9.5. As compared with the figures taken before operation they show a definite decrease in the size of the heart.

Case 16.—A laborer, white, aged 45, was admitted to the Johns Hopkins Hospital, May 20, 1921, for a pulsating exophthalmos of the left eye. The condition resulted from a direct blow on the left jaw received eight weeks previously. On the day after the accident he was conscious of a puffing sensation in the left ear, and on the second day he was annoyed by double vision and began wearing a shield over this eye. The noise in his ear became gradually more severe and the eye more prominent. Two weeks previous to his admission, the eye suddenly became markedly swollen and edematous, but from that time until admission very little change was noted.

Examination revealed the typical picture resulting from a fistula between the internal carotid artery and cavernous sinus (Fig. 4). A continuous bruit with systolic intensification could be heard over the entire head, but this was most marked in the left temporal region. There was an exophthalmos associated with a very marked edema of the conjunctiva, and eversion of the lids. There was a complete ophthalmoplegia of this eye; vision in it was very good. The eye grounds were normal except for slight distention of the vessels and some edema of the retina. Occlusion of the left common carotid caused almost complete disappearance of the bruit, the faintest sound being still audible in the temporal region. Occlusion of the right carotid artery did not produce any perceptible change in the character of the bruit; it did, however, cause the pulse rate to become definitely slower. No increase in the size of the left common carotid artery could be demonstrated. Precordial pulsation was rather forcible. The cardiac dulness extended 12 cm. to the left in the fifth interspace; it was not increased to the right. There was a loud systolic murmur at the aortic area. The blood pressure was systolic, 184; diastolic, 108; the pulse rate was 80. A roentgen-ray examination of the head revealed nothing abnormal.

Operation.—Operation was performed May 24, 1921, by me. Through a transverse incision the external carotid artery was ligated with heavy braided silk, and the common carotid occluded by an aluminum band one-quarter of an inch (6.35 mm.) wide. These vessels appeared to be about normal in size.

The exophthalmos and edema rapidly disappeared. The function of the third nerve was promptly resumed; the sixth was still paralyzed when he left the hospital. A faint bruit was detected in the left temporal region about thirty hours after the operation. On the second day, it was quite easily heard. On the night of May 26, the patient had a severe frontal headache. The bruit coincidently began to decrease in intensity, and on the day of his discharge (June 10, 1921) it was not audible. All symptoms were relieved, and the eye appeared normal except for the paralysis of the external rectus muscle and a slight injection of the blood vessels of the conjunctiva.

Case 17.—A man, white, aged 43, was admitted to the Johns Hopkins Hospital May 12, 1921, with an arteriovenous fistula between the left femoral vessels

Fig. 4 (Case 16).—Pulsating exophthalmos: left, the condition of the left eye eight weeks after the production of a fistula between the internal carotid artery and cavernous sinus; right, condition of the left eye seventeen days after the ligation of the common and external carotid arteries.

just below Poupart's ligament. A pistol shot received nine years previously had caused it.

The patient was large and obese. The superficial vessels of the left leg were conspicuous. The scar of a recently healed ulcer was present over the shin. The characteristic signs of an arteriovenous fistula were present over a wide area, but they were most marked directly over the fistula just below Poupart's ligament. Here, by pressure, one could make all the signs disappear. In this region, the large superficial vessels pulsated very perceptibly. The artery distal to the fistula could not be felt. No pulse could be felt either in the dorsalis pedis or posterior tibial arteries, while in the right foot the pulse

in both of these vessels was good. The heart was enlarged, the teleoroentgenographic measurements being median left, 13; median right, 4.5; longitudinal, 19.0; transverse, 13.5, but there was no evidence of cardiac decompensation. A faint systolic murmur could be heard over the apex beat. The electrocardiographic report, May 14, 1921 was: rate, 83; sinus arrhythmia; the P-R interval measured 0.15 second; venous pressure below fistula, 30 mm. of water; diagnosis, normal mechanism. The Wassermann reaction was negative.

Rosenau, by means of the Hooker-Danzer microscopic method, making observations on the capillaries of the toes at the junction of the nail and skin reported that there was a marked increase in the number of capillaries of the middle toe of the left foot as compared with the capillary bed of the corresponding toe of the right foot. A large percentage of the capillaries were dilated with stagnant blood. The average capillary pressure was 15 mm. of water. In the fourth toe of the left foot, there was a similar increase in the capillary bed. The capillaries were inactive, many being dilated and filled with stagnant blood. They were of wide bore and without pulsation. In the right foot, there were fewer capillaries; they were less dilated and fewer were inactive.

A comparison of the surface temperature of the two legs was extremely interesting. At a point about 6 cm. above the internal malleolus, the surface temperature appeared to be equal in the two legs. Below this point, the left foot was definitely colder than the right, and the contrast was more marked in the toes. Above this point, however, the left leg became much warmer than the right, the contrast being most marked over Scarpa's triangle. These differences in temperature must have been entirely due to variations in the circulation, for there was no evidence of any infection. The left leg above the knee was a little swollen, while below the knee there was some atrophy. Both legs measured the same length.

The lack of circulatory balance in the left foot could be demonstrated by changing the levels of the two feet, the left foot requiring much more time for the circulation to become adapted to a new level than did the right. For example, when the elevated left leg was dropped to a level position, a play of vascular colors took place before the final adjustment was made, the play of colors being in this order; red, blotchy red, cyanotic and less cyanotic. The time required for this adaptation was from three to five minutes. The circulation of the right foot adapted itself very quickly.

The patient had observed very definite variations in the condition of his leg and he spoke of a good day as being one on which "the leg felt less heavy"; "the beating was not so much"; "it was not so hot"; "the leg felt more use to him"; and "when he cannot feel it (thrill) so well." We were able to confirm his observations and noted that, coincident with his apparent improvement, the blood pressure in his arm was low. On one such day it was: systolic, 110; diastolic, 60. The usual blood pressure in his arm before operation was: systolic, 140; diastolic, 65.

Operation.—Operation was performed May 23, 1921, by me. The skin was sterilized with iodin and then covered with collodionized China silk.[7] The opera-

7. For many years Dr. Halsted tried various methods of covering the skin in order to avoid any contact with it during operations. While he was trying thin sheets of rubber and various other substances, it occurred to Dr. Heuer to use thin China silk saturated with collodion dissolved in ether, a method we still employ in all vascular cases.

tion as completed is illustrated by Max Brödel in Figure 6. A curved incision was made in order to avoid, so far as possible, the pulsating angiomatous veins in the subcutaneous fat.

The field of operation is thoroughly scrubbed with green soap and water, followed by alcohol and ether. It is then painted with 7 per cent. iodin and draped in the usual way. When the iodin is thoroughly dry, collodionized

Fig. 5 (Case 17).—Left femoral arteriovenous aneurysm of nine years' duration. The dilated blood vessels and the ulceration may be noted.

China silk is spread smoothly over the exposed area. The ether evaporates quickly, leaving the silk firmly attached to the skin; the incision is made through the silk, which is transparent.

Throughout the operation, all instruments, sponges and surgeon's hands are protected from the skin. This procedure seems to be a particularly wise precaution in these cases where often many hours are required to perform an operation, and where the consequences of wound infection may be so disastrous.

The fistula was so high that a tourniquet could not be used. Four Hoffman clamps were temporarily placed on the artery and vein above and below the fistula and the profunda artery was temporarily ligated by torsion with a piece of tape. After the fistula had been excised and the occluding clamps and tape had been released, a strong pulse promptly appeared in the distal end of the artery. This pulse could be markedly lessened, although it could not be

Fig. 6 (Case 17).—The fistula between the femoral vessels completely excised. The profound femoris artery and saphena magna vein were not ligated. The femoral vessels were enormously dilated; the large vessels in the subcutaneous tissue pulsated and contained arterial blood. The pulse, which had previously been absent in the foot, was easily felt as soon as the fistula was excised.

made to disappear, by the occluding of the profunda artery. From these observations, it seemed quite evident that the circulation would have been sufficient had we also ligated the profunda artery.

The fistulous opening was very large (2 cm. by 1 cm.). The femoral artery distal to the fistula was larger than normal, but much smaller than the dilated artery proximal to the fistula. The walls of the artery distal to the fistula were thin, having somewhat the characteristics of a vein, while those of the vein resembled the walls of an artery. Neither artery nor vein showed calcification.

At the completion of the operation, a very faint pulse could be felt in the dorsalis pedis artery (previous to the operation no pulse could be detected in the foot). After four hours, a pulse could be easily felt in both the dorsalis pedis and posterior tibial vessels, its volume being about one half that in the right foot. At the end of eight hours, the pulse in the left foot was as good as in the right. On the morning after the operation, the left dorsalis pedis and the posterior tibial vessels appeared larger than those vessels in the opposite foot; but the force of the pulse appeared the same on the two sides.

Within three hours after the operation, the circulation of the left foot was decidedly better than it had been before the operation. After eight hours the foot was warmer than the right. For several weeks the left foot remained warm and very actively congested, resembling at times an acute inflammation. On the fourth day, the surface temperature of the left foot was four degrees higher than that of the right foot. After one month, the temperatures of the two feet were nearly equal. The left dorsalis pedis artery, however, remained a little larger than the right. The stability of the circulation in the left foot improved from the time of operation. Cyanosis did not occur, and changes of position did not produce the evidences of circulatory embarrassment noted before operation.

July 18, 1921, the teleoroentgenogram of the heart showed: median right, 2; median left, 12; transverse, 10; longitudinal, 16.5; this was a marked decrease in the size of the heart (preoperative report, May 13).

At the time of the patient's discharge from the hospital July 25, the swelling of the left leg had disappeared; the pigmentation of the leg particularly around the old healed ulcer was less and, except for a moderate active hyperemia of the toes, the circulatory balance in the left leg appeared normal. The capillaries of the foot were smaller, and fewer of them were inactive. The pulses of the two feet were equal.

Dec. 28, 1922, the patient reported by letter that he was well and that his leg did not bother him.

Case 18.—A man, white, aged 35, was admitted to the Johns Hopkins Hospital Oct. 14, 1921, with an arteriovenous fistula between the left subclavian vessels, caused by a gunshot wound received five months previously. The wound healed without infection. The presence of a fistula was detected on the day of the accident. The arm began to swell very soon, and at the end of two months it was so large that he could not get it into his shirt sleeve. After this, the swelling tended to decrease, although at times there were slight exacerbations. These periods of rapid increase in size were not associated with fever, chills or nausea. The radial pulse varied; at times it was well felt, and at other times it was imperceptible to the patient. The patient also spoke of the great variability in the color of his hand; sometimes it was almost of the same color as the right; most of the time it was a little blue or cyanotic. The strength left his arm quickly whenever he tried to use it.

The arm and left shoulder were greatly swollen and pigmented; pulsations were visible in the basilic, cephalic and numerous subcutaneous veins over the

clavicle, but not in the distended external jugular vein; there were numerous telangiectases in the skin over and below the clavicle. The left radial pulse was very small, but it could be counted. When the arms were raised above the head the veins of the left arm remained engorged and distended and, on so testing, his left arm quickly "gave out on him" and fell to his side. When the left arm was dropped from an elevated position to a dependent one, the hand at first became red and actively hyperemic, changing in about one minute to a cyanotic color. A very loud arteriovenous thrill and bruit were present over a wide area, but firm pressure just above the junction of the middle and inner thirds of the clavicle obliterated these signs. The systolic blood pressure in the right arm was 120, in the left 60; the diastolic was 60 in the right arm and not measurable in the left. The venous blood pressure in the left external jugular was 14 cm. water; in the left cephalic, 22 cm.; in the median basilic, 40 cm. Physical, roentgen-ray and electrocardiographic studies of the heart failed to reveal any abnormalities.

The surface temperatures registered from 2 to 3 degrees higher over the left shoulder, clavicle and forearm than over corresponding points on the right side. At the elbows, the temperatures were about equal; in the left hand, they were 2 to 3 degrees lower than in the right.

Operation.—Operation was performed Oct. 26, 1921, by me. Two-thirds of the clavicle was removed subperiosteally, and the fistula, which was between the subclavian vessels in their third portion, was excised. The ends of the vessels were ligated with doubled heavy silk. The wound was closed with silk without replacing the resected portion of the clavicle. The operation was long and tedious because of the numerous blood vessels that had to be tied.

Contrary to the usual observations the artery in this instance was larger on the distal side than on the proximal side of the fistula.

Immediately after the operation, the left hand was cold and pale; no pulse could be felt at the wrist. Within three hours the hand had become pinker and warmer than the right, but no pulse was yet present at the wrist. The pulse at the right wrist was strong and good. About eighteen hours after the operation, a pulse one fifth the volume of the right was felt at the left wrist. This pulse rapidly improved and remained better than it had been before operation. However, its quality fluctuated markedly; at times it was almost as good as the right radial pulse, while at other times it approached the poor quality present before the operation.

The mere weight of the forearm on the chest wall during the first five days after operation, when the shoulder was in a cast, caused a little slough on its surface. This area healed promptly, and there was no permanent injury to the flexor tendons. The edema of the arm rapidly subsided until the arm, at the time of his discharge from the hospital, was normal in size.

For a few weeks after the operation, the left hand and forearm were warmer than the right; later, they became of the same temperature. The surface temperature around the left shoulder was still a little elevated when he left the hospital. The telangiectases and enlargement of the blood vessels were, however, disappearing.

On November 30, sphygmographic tracings revealed a marked improvement in the left radial pulse as compared with similar tracings before operation. The venous pressures were: left external jugular 2 cm. water; left cephalic, 4 cm.; left median basilic, 14 cm. The patient was discharged December 7, with the function of his arm rapidly returning to normal.

CASE 19.—A colored man, aged 43, was admitted to the Johns Hopkins Hospital Oct. 26, 1921, sixteen days after having received a gunshot injury to the right shoulder. The bullet entered just below the inner end of the clavicle and lodged near the lower angle of the scapula. At the time of the injury there was a profuse hemorrhage from the wound of entrance, and the arm was paralyzed. Dr. La Roque, who referred the patient to us, saw him very soon after the accident and discovered an arteriovenous fistula. There was some return of function in the arm and hand on the following day, and this improvement continued up to the time of his admission.

On examination, the thrill and loud continuous bruit indicated that the fistula was in the third portion of the subclavian vessels. The bruit was audible in the arm as far as the wrist, over the right chest front and back, and all over the precordium. The swelling about the shoulder had entirely disappeared; but the superficial vessels had not yet dilated, nor did they pulsate. The basilic and cephalic veins were distended but not pulsating. The deltoid muscle was paralyzed; all of the muscles of the arm and forearm were weak, particularly those supplied by the ulnar and median nerves. The right radial pulse was much weaker than the left. The average blood pressure for the right arm was: systolic, 99; diastolic, 52. For the left arm it was: systolic, 131, diastolic, 64. The venous pressure in the right basilic vein was 19 cm. water; in the left basilic vein, 6 cm. Except that the bruit of the fistula obscured the heart sounds, the heart appeared to be normal. Electrocardiograms showed a normal cardiac mechanism. The surface temperature of the right arm was generally the same as the left. Compression of the subclavian artery obliterated the thrill but did not cause the bruit to disappear entirely.

Operation.—Operation was performed November 3, by me. In the tissues, particularly in the pectoralis major muscle, there was considerable unabsorbed blood. The clavicle was divided at the junction of its middle and outer thirds. The operation was completed as shown in Figure 8. The artery proximal to the fistula was noted to be definitely dilated, measuring 1 cm. in diameter; distal to the fistula, the diameter of the artery was 0.7 cm. After laying ligatures about the vessels at the four cardinal points, an effort was made to dissect free the vessels at the site of the fistula. This procedure was very difficult on account of the edema and inflammatory reaction around them. Moreover, the walls of the vessels injured by the bullet had not become sufficiently well healed to permit an easy dissection to be made without tearing them. Finally convinced that a restoration of the vessels was not feasible, I tied the two vessels at the four cardinal points with doubled, heavy black silk. Even then, the excision of the fistula was troublesome on account of the hemorrhage from large branches joining the vessels at the fistulous opening. When the excision had been carried so far that the communication between the vessels would with certainty be occluded, the operation was terminated as shown in Figure 8. The clavicle was wired, and the wound was closed with silk sutures without drainage.

Convalescence was uncomplicated. The circulation of the right arm remained good. The surface temperatures registered about the same in both arms. For a short time there was an accentuation of the weakness in the muscles, but there was no sensory disturbance. At times the radial pulse was definitely felt, being felt best on the fourteenth day; but at no time during his convalescence was it possible to count the radial pulse. December 3, polygraphic tracing of the right brachial artery gave small waves; there were no excursions

from the right radial artery. The venous pressure in the right basilic vein was 8 cm. water. No thrill nor bruit was present. The heart sounds were clear. The patient was discharged December 7.

CASE 21.—A man, white, aged 42, was admitted to the Johns Hopkins Hospital Dec. 14, 1921, with a large pulsating hemangioma of the lower lip (Fig. 9). The condition began after a blow on his lip, received when he was 9 years old. A little tumor, soft and compressible and about the size of a pea soon

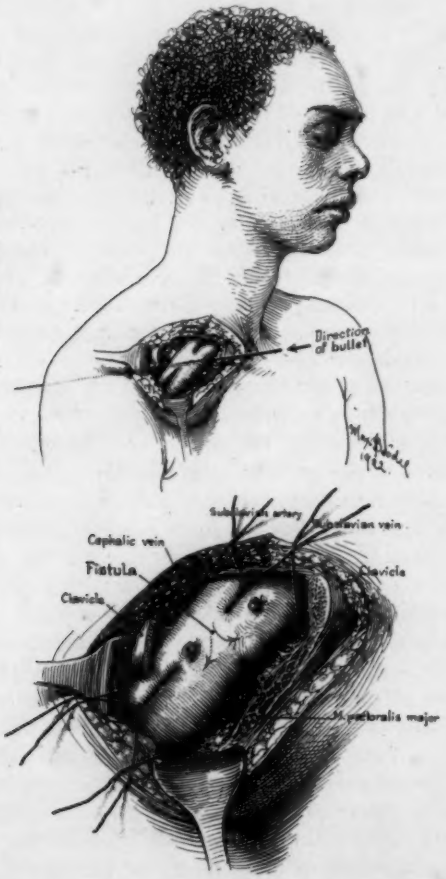

Fig. 7 (Case 19).—Subclavian arteriovenous aneurysm twenty-three days old. The bullet traversed both walls of the artery and vein; reaction about the vessels at the site of fistula may be noted. Ligatures were placed and tied, preliminary to excising the fistula.

appeared. At the age of 19, because the swelling had increased a little in size, an attempt was made to remove it. Considerable blood was lost during the operation, and no improvement resulted. Five years later, the tumor had grown to the size of a hickory nut. At this time both facial arteries were ligated, but without any improvement resulting. Six months later the left common carotid artery was ligated. He says that he was blind in both eyes

for thirty-six hours after the operation, and that sight was restored only after the ligature from the common carotid artery was removed. The swelling continued to increase in size and to pulsate more forcibly. During the last two years, he had had several severe hemorrhages from abrasions on the lip, and on several occasions, the blood spurted from the wound for a distance of two or three feet.

The lower lip and the entire left cheek were involved by a pulsating growth which seemed to be made up almost entirely of blood vessels. A thrill, most marked just below the chin, could be felt over the growth, and a loud continuous bruit was everywhere present. Pressure applied anywhere failed to

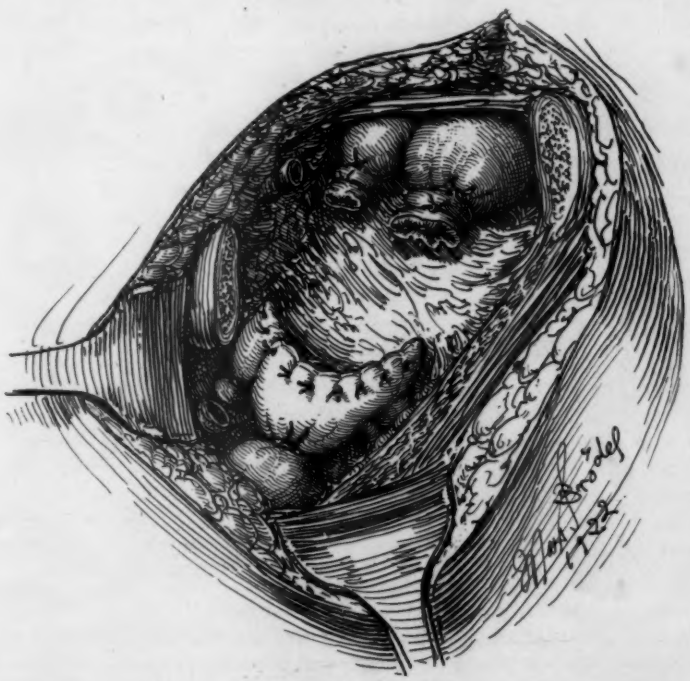

Fig. 8 (Case 19).—The completed operation. Although the four cardinal points were ligated, there was free bleeding when the fistulous area was excised, and it was necessary to place the mattress sutures in order to control it. This appeared to be easier than to attempt to ligate the branches coming in posteriorly.

abolish either the thrill or bruit, although these signs of a free arteriovenous communication could be diminished by pressure just below and to the left of the chin. A diagnosis of pulsating hemangioma or cirsoid aneurysm was made. The patient refused operation.

Case 24.—A white man, aged 38, was admitted to the Cincinnati General Hospital Feb. 11, 1922, after having received a gunshot injury to the neck. The right arm was partially paralyzed, but sensation was not disturbed. The radial pulse was absent. On the following day, the unmistakable signs of an

arteriovenous fistula between the right subclavian vessels were present. During the next two weeks the thrill became so marked that it annoyed the patient, and the veins of the neck began to dilate and to pulsate. A weak radial pulse returned on the second day; the partial paralysis of the arm disappeared within ten days.

For two months the veins continued to enlarge, and the fistula showed no evidences of healing spontaneously; at that time an operation was refused. At the end of four months the thrill and bruit were much reduced, and at six months the signs of an arteriovenous fistula had disappeared. At the time of his last presentation, the arm tired easily; often, this fatigue appeared suddenly. He said that he could not trust it, and that he had given up washing windows because he was afraid of falling when the strength would suddenly leave the arm. The radial pulse was about one half as strong as in the other arm. Just above the inner end of the clavicle there was a small swelling; this had the characteristics of a simple aneurysm, but there was no evidence of a fistula.

Case 25.—A man, white, aged 41, was admitted to the Cincinnati General Hospital May 29, 1922. He had been shot below the left clavicle six months previously. A loud noise and the unmistakable signs of an arteriovenous fistula were detected on the day of the accident. For a few weeks there was a partial motor and sensory paralysis of the arm. At first, the thrill was so marked that "the covers of his bed seemed to quiver." The intensity of this thrill decreased rapidly during the first month; after that it decreased more slowly. For several months, he himself had been scarcely able to feel the thrill. The doctor, however, reported that he had observed no change in the last two months. The radial pulse had been very good ever since the accident.

Examination.—A faint thrill and a moderately loud bruit were present both above and below the clavicle. They disappeared on compression of the subclavian artery. The radial pulse was about two-thirds normal in volume. There was no edema of the arm, nor was the surface temperature elevated. The heart was normal in size and rhythm. The pulse rate was 70. Blood pressure in the left arm was: systolic, 105; diastolic, 80. In the right, it was: systolic, 120; diastolic, 85.

Operation.—Operation was performed Nov. 21, 1922, by me. The clavicle was divided and the subclavian vessels were exposed. The fistula was in the third portion of the artery. After a long and painstaking dissection requiring several hours, the vessels were freed and separated, except for the fistula. This was about the size of the subclavian artery and bridged the anterior surfaces of the vessels. The fistulous connection was ligated with silk. The thrill and bruit disappeared. The lumens of the vessels were not encroached on. On the artery, at its junction with the fistula, was a little dilatation half the size of a cherry. It was believed that this would disappear after the fistula was closed. The artery distal to the fistula was a little larger than it was on the proximal side. The clavicle was wired, and the wound was closed with silk without drainage.

The wound healed by first intention. The radial pulse became as good on the left side as it was on the right. The blood pressure was: systolic, 120; diastolic, 85 in both arms. The patient was discharged eleven days after the operation. He has remained well and has perfect use of his arm.

Case 26.—A colored man, aged 57, was admitted to the Cincinnati General Hospital Dec. 23, 1922, immediately after he had been shot in the left leg. The bullet had entered the thigh just below the trochanter and was lodged in

the skin over the apex of Scarpa's triangle. There was a large hematoma. A marked thrill and bruit were present. The veins of the leg were dilated. The left foot was colder than the right. The pulse in the dorsalis pedis and posterior tibial arteries was present, but it was very weak. However, circulation seemed sufficient, and there was no threatening gangrene. We decided to wait for the development of a collateral circulation and a possible spontaneous cure of the fistula.

After twenty-four hours the skin had become so thin over the bullet, due to the pulsation of the swelling, that its early rupture seemed certain. Consequently operation was immediately decided on.

Operation.—Operation was performed December 24, by me. A tourniquet was used. The femoral artery was found to be almost divided; the vein, about

Fig. 9 (Case 21).—Cirsoid aneurysm of the lower lip following an injury received thirty-three years before.

three-fourths severed. After the artery was completely divided and its frayed ends were trimmed, an end-to-end anastomosis seemed unwise; for the tension would have been too great, especially in the presence of the enormous hematoma and blood-soaked tissues. The ends of the artery were, therefore, doubly ligated with heavy silk. The femoral vein was divided and ligated with transfixion sutures of medium silk. The long saphenous vein was ligated and divided. This point will be discussed later. The skin was closed very loosely; no buried sutures were placed in the muscles or subcutaneous tissues.

The leg was kept elevated and warm, and was frequently massaged from the foot toward the knee. For ten days, the superficial veins below the knee were very distended and prominent, even though the leg was elevated. After that they gradually collapsed. The circulation in the foot remained good. A pulse was detected in the foot on the twenty-sixth day; on the seventy-seventh, the day of discharge, it was equal to about two-thirds the volume of the right

pedal pulse. The wound healed by first intention. The function of the leg was very good. We were unable to see this patient after he left the hospital.

CASE 27.—A student, aged 19, was admitted to the Cincinnati General Hospital April 19, 1923, with a small but rapidly growing cirsoid aneurysm of the scalp. The swelling pulsated, and the redness was caused by the dilated vessels in the skin. In the scalp, for a distance beyond the tumor, the arteries were quite large and tortuous. The condition had developed after he had received a kick in a football game seven months previously.

Operation.—Operation was performed April 21, by me. An eliptical piece of the scalp 3 by 1¾ inches (7.62 by 3.84 cm.), including the tumor, was excised down to the periosteum. Bleeding was temporarily controlled by pressure on the scalp. The large arteries were ligated. The sutures placed in the galea and skin controlled the bleeding from the smaller vessels. There has been no evidence of a return of the condition since the operation.

The specimen was injected with Hill's solution (bismuth oxychlorid in acacia) and then cleared. It showed a very free communication between the mass of arteries and veins making up the tumor.

CONGENITAL ABNORMAL ARTERIOVENOUS COMMUNICATIONS

In this group there are six cases. Abstracts of Cases 29, 30, 31 and 33 are given; the others are reported in the tables.

CASE 29.[8]—A girl, white, aged 11, was admitted to the Johns Hopkins Hospital Nov. 3, 1911, complaining of a throbbing swelling in the right side of her neck. Within three days after birth (a normal spontaneous delivery) a "buzzing and throbbing" was discovered in her neck. An actual swelling was not observed until the child was 8 years old. During the three years previous to her admission to the hospital, there had occurred frequent attacks of earache, toothache and pain in the right eye and right side of the face. Occasionally, she had suffered from severe dizzy spells.

Below the lobule of the right ear was a pulsating swelling measuring 3.5 by 4.5 cm. A thrill and a continuous bruit, accentuated in systole, were present over the tumor. Pulsation, thrill and bruit disappeared on direct pressure just below the ear and on occlusion of the carotid artery. There was no facial asymmetry. The color of the right face was normal and the superficial veins were not dilated. The heart was not enlarged and gave no evidence of being abnormal.

At the operation,[9] performed by W. S. Halsted, Nov. 15, 1911, a fistulous communication between the external carotid artery and a large vein was excised. The external and common carotid arteries were markedly dilated, while the internal carotid appeared smaller than normal. At the first dressing,

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8. W. S. Halsted first reported this case in the Transactions of the American Surgical Association for 1919 under the title of "Congenital Arteriovenous and Lymphaticovenous Fistulae." It was again mentioned by the author as an example of a congenital arteriovenous fistula in his article on "The Effect of Arteriovenous Fistula upon the Heart and Blood Vessels" (Footnote 6). It is again reported because the case certainly seems to be an example of a cirsoid aneurysm.

9. The operation is well described and illustrated by Halsted in the Transactions of the American Surgical Association for 1919, p. 262.

six days after the operation, a small tumor was still present, which pulsated slightly. The thrill and bruit were still present, though greatly reduced in intensity. Her annoying symptoms, dizziness, earache, toothache, etc., were entirely relieved.

May 15, 1918, the patient was again admitted to the hospital, complaining that her neck worried her more than ever before. A sensation of numbness and throbbing, particularly at night, was her chief annoyance. Occasionally, she felt pain just above the right eye; dizziness was experienced only when she became excited. Since her last operation she had not suffered from earache, toothache or headache. Her face, however, had become swollen.

On examination, a striking difference was observed in the appearance of the two sides of the face and neck. The right side, including the ear, was slightly cyanotic while in the skin there were numerous dilated venules. This entire side was swollen and resembled an hemangiomatous condition, most marked in the eyelids where large tortuous veins could be seen. The point of maximum swelling and pulsation was exactly in the region of the parotid gland. The ear pulsated. A thrill and bruit were present over a large area, but were most intense in the region of the parotid, where firm pressure made the pulsation, thrill and bruit disappear. It seemed to Dr. Halsted that the condition had become markedly worse during the last year.

The right common carotid artery appeared to be about three times as large as the left; on compression, the swelling below the ear subsided and ceased to pulsate, the distended veins collapsed and the cyanosis largely disappeared. The compression gave her relief which she expressed by saying that the right side of her face felt "lighter." Immediately on releasing the artery, she rotated her head and said that her face felt "heavy."

When the carotid artery was compressed, she complained of a "skim" coming over her right eye; when the fistula was occluded by the application of direct pressure over it, her eye felt brighter and clearer. The veins in the fundus of the right eye were very large. They collapsed to about normal size when the carotid was compressed. The margins of the disk were clear.

A careful study of the heart by means of physical examination, roentgen rays and electrocardiograms revealed no abnormalities. The systolic blood pressure was 110; the diastolic, 80. The Wassermann reaction was negative.

At the second operation which I performed May 24, 1918, another fistulous connection immediately behind the parotid gland was excised, and with about the same results as those following the first operation. At the first dressing, six days later, neither pulsation nor thrill were present, but a faint bruit could be heard. The cyanosis had disappeared, and the veins of the face had become inconspicuous. Obliteration of the common carotid, by pressure, did not affect the intensity of the bruit noted on the sixth day. The fistulous communication at this second operation was with an aberrant artery which had become markedly dilated and occupied the position of the original external carotid artery.

For four years the patient has been working in a laundry and has been entirely free of all the discomforts she had before the last operation, except that her head has "felt queer" when she stooped. The condition in her face and neck has been growing gradually worse. On March 14, 1922, I made my last observation. In the upper eyelid and the outer end of the eyebrow there was a typical angiomatous condition. The face and forehead presented the same picture but to a less marked degree. The dilated veins did not pulsate. The pulsating tumor below the right lobe of the ear had definitely increased in size.

TABLE 1.—*Acquired Abnormal Arteriovenous Communications*

Case	Date and Hospital	Age; Sex; Color; Occupation	Location of Lesion	Etiology	Duration	Type	Operator	Treatment	Result	Comments
1	5/21/97 J. H. H.	37 Male White Laborer	Left popliteal space	Bullet	8 yr.	Arteriovenous aneurysm of the popliteal vessels	Halsted, Bloodgood	1. Hunterian ligation of the popliteal artery 2. Amputation of leg for gangrene, ten days after the ligation	Well	Heart enlarged and pain over it; case reported and illustrated by the author in the Bull. Johns Hopkins' Hospital 31, No. 348 (Feb.) 1920
2	1/22/01 J. H. H.	37 Male White Farmer	Left Hunter's canal	Bullet	2½ mo.	Arteriovenous aneurysm of the femoral vessels	Halsted	1. Hunterian ligation of the femoral artery 2. One month later ligation of popliteal artery distal to aneurysm 3. Thirteen days later, amputation for gangrene	Well	Case was not recognized as an arteriovenous fistula until after the leg was amputated, although a definite thrill was noted over the swelling
3	11/26/01 J. H. H.	19 Male White Farmer	Left Hunter's canal	Stab wound with knife	3 mo.	Arteriovenous aneurysm of the femoral vessels	Halsted	Ligation of artery proximal and distal to fistula; lateral suture of vein with probable restoration of its lumen; partial excision of sac	Well	Patient developed intermittent claudication which persisted, being present when the patient was last seen, May 17, 1922
4	12/26/04 J. H. H.	23 Male White Teacher	Right hand, palmar surface	Playing baseball	10 yr.	Pulsating angioma (aneurysmal varix or arteriovenous aneurysm)	Finney	Ligation of radial artery and partial excision of vessels in palm of hand	Improved	No fistulous openings were found at time of operation; the angioma continued to pulsate afterward
5	5/5/05 J. H. H.	28 Male White Carpenter	Intracranial, right side	Fracture base of skull	3 yr.	Arteriovenous aneurysm between internal carotid artery and cavernous sinus; pulsating exophthalmos	Cushing	Ligation of the internal carotid artery	Well after 8 yr.	It required eight years before all symptoms and signs of the aneurysm disappeared; this case is recorded by Cushing in J. H. Hosp. Surg. Hist., Nos. 17702 and 2906
6	8/7/05 J. H. H.	31 Male White Farmer	Left occipital region	Puncture wound and bruise	7 yr.	Arteriovenous aneurysm of occipital vessels	Cushing	Ligation of external carotid artery and excision of aneurysmal varix	Well	The specimen showed a small opening between occipital artery and vein; there was a large mass of blood vessels
7	2/12/08 J. H. H.	55 Male White	Right hand, palmar surface	Blow from axe handle	25 yr.	Pulsating angioma	Follis	Excision of arteriovenous aneurysm of right hand; amputation of middle finger	Well	No definite fistula was found; all the veins pulsated; a thrill and bruit were present
8	2/9/11 J. H. H.	55 Male White Blacksmith	Right femoral region	Piece of flying steel	4 mo.	Arteriovenous aneurysm between femoral vessels 4 inches below Poupart's ligament	Halsted	Application of metal band to femoral vein proximal to fistula	Improved	In 1918 the patient wrote that his condition was about the same as before the operation
9	7/7/13 J. H. H.	47 Male Colored Laborer	Left femoral region	Bullet	30 yr.	Arteriovenous aneurysm between femoral vessels	Heuer	Division of the fistula; lateral suture of the vessels with restoration of their lumens	Dead	Patient died from gangrene of the lung and empyema; pulmonary emboli were the cause of the infarction of the lung
10*	10/13/16 J. H. H.	48 Male Colored Laborer	Right Hunter's canal	Stab wound	25 yr.	Arteriovenous aneurysm between femoral vessels	Halsted	Division of the fistula; lateral suture with restoration of both vessels	Well	In May, 1923, the patient's leg at the middle of the thigh was amputated because of gangrene which was produced by a large true aneurysm of the femoral artery just below Poupart's ligament (case report No. 10)

* Case fully reported in text.

11	4/17/17 J. H. H.	48 Male White Farmer	Intra-cranial, right side	Blow on head	14 mo.	Arteriovenous aneurysm between the internal carotid artery and cavernous sinus; slight pulsating exophthalmos	Heuer	Occlusion of internal carotid artery by means of a metal band	Well	Developed a premature cataract in right eye and became blind; evidences of a fistula disappeared; he, however, continued to suffer from dizziness, especially on stooping over; he was last seen one year after the operation
12	3/19/18 J. H. H.	55 Male Colored Farmer	Intra-cranial, left side	Fell on the ice	2½ mo.	Pulsating exophthalmos; arteriovenous aneurysm between internal carotid artery and cavernous sinus	Halsted	Occlusion, by metal bands, of both the common and internal carotid arteries	Well	No improvement for three days; then there was a sudden thrombosis followed by a rapid and complete cure
13	1/3/20 J. H. H.	24 Male White Farmer	Right popliteal	Bullet	6½ yr.	Arteriovenous aneurysm of the varicose type between the popliteal vessels; weak pulse in foot	Dandy	Excision of the sac; restoration of both vessels by means of lateral sutures; bullet removed	Well	On the sixth day the patient spat up some blood, and there was pain in his chest; probably a small embolus; pulse in foot was greatly improved by the operation; mild infection of wound
14	1/15/20 J. H. H.	34 Female White Clerk	Right neck	Stab with point of scissors	32 yr.	Arteriovenous aneurysm between external carotid artery and external jugular vein	Reid	Excision of the fistula; quadruple ligation of the vessels	Well	Cardiac hypertrophy and mitral insufficiency; common carotid artery dilated; marked bradycardia was present for several days after the operation; heart decreased rapidly in size
15	2/9/21 J. H. H.	19 Male Colored Laborer	Left forehead	Probably a blow	3 yr.	Pulsating angioma, half the size of a walnut	Heuer	Complete excision of the tumor	Well	Temporal vessels were markedly dilated
16*	5/20/21 J. H. H.	45 Male White Laborer	Left intra-cranial	A blow on the left jaw	8 wk.	Arteriovenous aneurysm between internal carotid artery and cavernous sinus; pulsating exophthalmos; ophthalmoplegia	Reid	Occlusion of the common carotid artery with a metallic band; ligation of the external carotid artery with silk	Well	The heart was enlarged; eye became normal except for a permanent palsy of the sixth nerve; the disappearance of the bruit was gradual, requiring ten days
17*	5/12/21 J. H. H.	43 Male White Merchant	Left femoral	Bullet	8½ yr.	Arteriovenous aneurysm between the femoral vessels just below Poupart's ligament; no pulse in foot	Reid	Excision of the fistula; quadruple ligation of the vessels	Well	Immediate return of pulse in foot; ulcers of leg promptly healed; April 21, 1922, patient entirely well; no swelling of leg
18*	10/14/21 J. H. H.	35 Male White Laborer	Left subclavian	Bullet	5 mo.	Arteriovenous aneurysm between the left subclavian vessels in their third portion; swollen arm; poor pulse at wrist; heart normal	Reid	Excision of the fistula; quadruple ligation of the vessels	Well	Swelling of arm promptly disappeared; pulse at wrist returned in twelve hours and was almost as strong as that in the right within two days; after that its volume was variable; April 29, 1922, "left arm is almost as strong as the right one"
19*	10/26/21 J. H. H.	43 Male Colored Laborer	Right subclavian	Bullet	16 da.	Arteriovenous aneurysm between the right subclavian vessels in their third portion; paralysis of deltoid muscle and partial paralysis of flexors of hand	Reid	Excision of the fistula; quadruple ligation of the vessels	Well	Radial pulse was occasionally perceptible after operation but never as good as before it; for several days postoperative twitchings of the fingers were noted

TABLE 1.—*Acquired Abnormal Arteriovenous Communications—Continued*

Case	Date and Hospital	Age; Sex; Color; Occupation	Location of Lesion	Etiology	Duration	Type	Operator	Treatment	Result	Comments
20*	1/27/22 J. H. H.	9 Male White Schoolboy	Left side of scalp	Birth hematoma	9 yr.	Cirsoid aneurysm; the vessels of the scalp were large and tortuous; a swelling the size of one's thumb at the point of maximum thrill and bruit	Holman	Excision of pulsating angioma of the scalp; tourniquet used	Well	This seems to be clearly a case in which injury at birth was responsible for the anastomosis; excision of the central mass, where the anastomoses were, was followed by a cure
21*	12/14/21 J. H. H.	42 Male White Laborer	Lower lip	A blow on the lip at age of 9	33 yr.	Cirsoid aneurysm, pulsating hemangioma or aneurysm by anastomosis; marked thrill and bruit	.....	Refused operation	Not treated	There seemed to be numerous large communications between the arteries and veins, for the bruit, thrill and pulsation could not be stopped by pressure at any one point
22	2/28/22 J. H. H.	48 Male White Laborer	Right femoral vessels	Stab with a knife	1 mo.	Arteriovenous aneurysm between the femoral vessels in Hunter's canal; pulse in foot	Reid	Division of the fistula restoration of artery and vein	Well	The pulse in the foot became markedly better than on the opposite side; marked peripheral dilatation and increase in local temperature; April 20, 1922, patient writes that there is no weakness of the operated leg and that the pulse "in the ankle" of this leg is still better than it is in the opposite leg
23	8/9/22 J. H. H.	41 Male White Laborer	Left popliteal vessels	Bullet	25 yr.	Arteriovenous aneurysm between the popliteal vessels; cardiac hypertrophy and dilatation with decompensation	Holman	Division of the fistula; lateral suture of the vessel walls with restoration of their lumens	Well	Heart decreased perceptibly in size within thirteen days; case fully reported by Holman in the Archives of Surgery **7**: 64-82 (July) 1923
24*	2/11/22 Cincinnati General Hospital	38 Male White Laborer	Right subclavian	Bullet	1 day	Arteriovenous aneurysm in first portion of subclavian vessels; very marked thrill and bruit; rapid enlargement of veins	.....	Operation was deferred for several months until the collateral circulation should develop and the tissues become well healed	Well (spontaneous healing)	After about two months the thrill and bruit began to disappear and the pulsation became less; at the end of six months the signs of an arteriovenous aneurysm had disappeared
25*	11/18/22 Cincinnati General Hospital	41 Male White Laborer	Left subclavian	Bullet	6 mo.	Arteriovenous aneurysm in the third portion of the subclavian vessels	Reid	Ligation of the fistula; lumens of the vessels were not disturbed; the fistula was equal in size to the artery	Well	During the first month the signs of an aneurysm decreased rapidly; after that more slowly; in this instance, a spontaneous cure might have resulted if we had waited longer; the fistula was small; the artery beyond the fistula was larger than it was on the proximal side
26*	12/23/22 Cincinnati General Hospital	37 Male Colored Laborer	Left femoral vessels	Bullet	2 da.	Arteriovenous aneurysm between the femoral vessel at the apex of Scarpa's triangle	Reid	Excision of the fistula and quadruple ligation of the vessels; ligation and division of the long saphenous vein	Well	Circulation in the foot remained good; pulse was palpable and countable in the foot on the twenty-sixth day after the operation
27*	4/19/23 Cincinnati General Hospital	19 Male White Student	Scalp; occipital region	A blow on the head	7 mo.	Pulsating angioma of scalp; the tumor appeared immediately after the abrasion healed	Reid	Excision of the pulsating angioma	Well	The blow, received in the football game, established a free communication between the arteries and veins

* Case fully reported in text.

The typical arteriovenous thrill and bruit were present over it. The difference in the size of the two carotid vessels still existed. Occlusion of the right carotid artery alone had but slight effect on the bruit, and occlusion of the left carotid artery alone diminished it almost to the same extent. Occlusion of both carotid vessels made the bruit disappear entirely. It would appear, therefore, that the fistula received as much blood from the left side as from the right. The patient's heart was normal.

I was convinced that the condition with which we were dealing was rather of the nature of a pulsating nevus than of the so-called true arteriovenous aneurysm.

CASE 30.—A boy, white, aged 18, first came under observation Sept. 17, 1918. He complained of a "lump in his neck." In his family and past histories I

Fig. 10 (Case 30).—Congenital arteriovenous aneurysm: left, before operation; right, one month after the first operation. The age of the patient was 18 years. The dilated veins pulsated like arteries, and over them were a strong thrill and loud bruit. The portion of the aneurysm extending back under the trapezius muscle was not excised, and the subclavian fistula is still active.

could learn of nothing that might have a bearing on his present illness. At the age of thirteen, or about five years previous to his admission to the hospital, he accidentally discovered a little swelling in the right supraclavicular fossa. For several years before this time he had noted a puffing noise in this region, particularly when he was lying in bed on the right side. At first the swelling was a soft mass about the size of his little finger, running back toward the trapezius muscle; for five years, it had increased at a uniformly rapid rate, but had never been associated with pain nor disability. The fear of a rupture of the pulsating mass, its rapid growth and the annoyance of the bruit made him demand an operation, which, I am sure, no surgeon would have done without great hesitation. For a year he had worn an elastic compressor, made

like a Sam Brown Army belt, over the aneurysm, with the idea of strengthening its walls.

Examination (Fig. 10, left).—A large, lobulated, pulsating mass filled the right supraclavicular fossa and hung over the clavicle upon the chest wall. The trapezius muscle bulged and pulsated; the growth evidently extended beneath it well down upon the scapula. Huge vessels extended upward in front and behind the ear, and the veins of the right scalp were dilated. The skin over

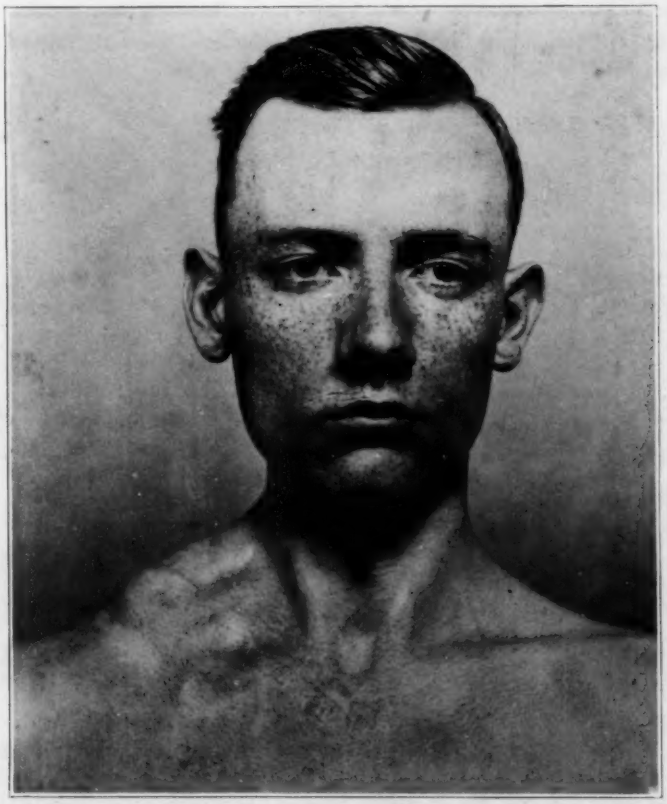

Fig. 11 (Case 30).—The condition fourteen months after the first operation and just prior to the second when the subclavian fistula was found and ligated; the dilated vessels are rapidly recurring.

the main part of the aneurysm was thinned, bluish, and contained many dilated venules. The right ear was slightly cyanotic, and there were dilated vessels in the right lower eyelid. The face was symmetrical. The pupils were alike and normal.

On palpation, a strong pulsation was present in all parts of the swelling. To firm pressure, the pulsation deeper in the neck seemed more forcible and like that of a true arterial aneurysm; superficially, the dilated vessels were certainly pulsating veins. A thrill could be felt over the entire aneurysm, but it was most marked in two places; just in front of the trapezius muscle at the outer

TABLE 2.—*Congenital Abnormal Arteriovenous Communications*

Case	Date and Hospital	Age; Sex; Color; Occupation	Location of Lesion	Etiology	Type	Operator	Treatment	Result	Comments
28	8/5/07 J. H. H.	23 Female White Seamstress	Lower eyelid, left	Congenital	Cirsoid aneurysm involving the external two-thirds of the lower lid; increasing slowly for eighteen years	Miller	Excision of the aneurysm	Well	"The communicating branch was from the ophthalmic artery"
29*	11/3/11 and 5/15/18 J. H. H.	11 and 18 Female White Schoolgirl	Right face and neck	Congenital	Arteriovenous aneurysm between external carotid artery and external jugular vein; multiple large communications	(1) Halsted, 1911 (2) Reid, 1918	(1) "Excision of veins of neck; ligation of external carotid artery for aneurysmal varix of neck" (2) Partial excision of arteriovenous fistulas of the neck	(1) Improved (2) Improved	At each operation a rather large fistula was found and its excision caused marked improvement; in each instance the faint signs of another fistula were detected about one week after operation; this case may more properly be called a pulsating angioma or cirsoid aneurysm
30*	2/19/19 and 5/17/20 J. H. H.	19 Male White Jeweler	Right subclavian and transverse coli vessels	Congenital	Arteriovenous aneurysms; Marked thrill and bruit	(1) Reid, 1919 (2) Reid, 1920	(1) Partial excision of the dilated pulsating veins; ligation of the transverse coli artery (2) Ligation of a large fistula from the subclavian artery and other ligations of blood vessels as shown in drawings	(1) Improved (2) Well	In this instance there seemed to be only two large fistulas connecting the arterial with the venous system; the patient has remained cured; there are now no signs of an arteriovenous fistula, and the swelling is gone
31*	5/21/21 J. H. H.	36 Female White Housewife	Left anterior tibial vessels	Congenital	Cirsoid aneurysm; femoral vessel enlarged; heart normal; leg lengthened	(1) Reid (2) Reid	(1) Excision of the popliteal vein and ligation of the branches of the popliteal artery (Fig. 19) (2) Amputation of the leg at the middle of the thigh	Well	The communications between the arteries and veins were within the tibia; rupture of the popliteal artery, with extravasation of blood, led to gangrene; the arterial wall was almost as thin as that of a vein; circulation in the foot was good until the artery burst
32	2/8/22 J. H. H.	19 Male White Clerk	Cerebral vessels, right	Congenital	Cirsoid aneurysm; Jacksonian epilepsy for seven years; heart normal	Dandy	Ligation of large cortical arteries and veins, followed by almost immediate rupture of these vessels, and death from hemorrhage	Dead	Veins and arteries were dilated; both contained arterial blood and pulsated; thrill and bruit could be felt; the walls of the vessels were abnormally thin; they burst proximal to a ligature
33*	10/30/23 Cincinnati General Hospital	16 Male White Schoolboy	Internal carotid artery and cavernous sinus	Congenital	Probably a cirsoid aneurysm; pulsating exophthalmos	.....	Not treated	.....	Cases of congenital pulsating exophthalmos are extremely rare

* Case fully reported in text.

end of the clavicle, and just above the middle of the clavicle. By tapping gently with the finger any one of the dilated veins, definite fluid waves were transmitted to all of the others and especially to the external jugular vein. By constant firm pressure, the entire aneurysm could be collapsed. It refilled almost immediately on release of the pressure. A bruit typical of an arteriovenous aneurysm was present over the entire swelling, but it was most marked at the points corresponding to the maximum thrills. Firm, deep pressure just above the middle of the clavicle caused the pulsation to cease, and the thrill and bruit to disappear. Pressure over the point of marked thrill at the border of the trapezius diminished, but did not cause the thrill or bruit to disappear. The spine of the scapula was very sensitive.

The right arm appeared to be normal. Its measurements were about 1 cm. larger than those of the left, except at the right wrist where both were of the same size. There were no nerve disturbances. The radial pulse was good. The blood pressure in the right arm was: systolic, 93; diastolic, 40. In the left arm it was: systolic, 108; diastolic, 52.

The heart, studied by physical, electrocardiographic and roentgen-ray examinations, was normal. By fluoroscopic examination, we were unable to see the innominate artery. The eye grounds were normal.

October 5, the patient developed influenza. After his recovery from this disease, he was sent home to wait for several months before undergoing an operation; he returned Feb. 19, 1919. During his absence, the telangiectases in the skin had become more marked, and the external jugular vein a little larger; otherwise, there was no change.

Operation.—The first operation was performed Feb. 25, 1919, by George J. Heuer and myself. At this operation we worked for six hours, and were unable to do more than remove a portion of the aneurysm. The mass of tortuous, huge, thin-walled, pulsating vessels offered such a barrier that we were unable to reach the subclavian artery at this sitting. Finally, we ligated and divided the external jugular vein just below the ear, and again at its entrance into the subclavian vein. This vessel was about 3 cm. in diameter. Next, the vessels were lifted off the clavicle. The entire mass could then be dislocated laterally, permitting exposure of the common carotid artery and jugular vein. On doing this, we found the transverse coli artery, which was about the size of one's little finger. The pulsation in it was unusually strong. Occlusion of this vessel caused a marked decrease in the pulsation of the aneurysmal mass and a great diminution in the intensity of the thrill. It was ligated and divided. After dividing a few large vessels which ran posterior to the outer end of the clavicle, we were able to deliver in part the mass of circumscribed vessels. This mass, however, extended far behind the trapezius muscle and down below the clavicle around the subclavian vessels. Completion of the operation seemed certainly inadvisable. We therefore terminated this first stage by placing a stomach clamp across the freed portion of the aneurysm and excising a large portion of it. Bleeding was controlled by placing a cobbler's stitch of heavy silk close to the openings of the divided vessels. When the clamp was removed, the remaining mass filled slowly and began to pulsate. The wound was closed with silk and without drainage. The patient left the table in good condition, with a pulse rate of 112.

At the time of his discharge from the hospital, March 31, there was practically no deformity (Fig. 10, right). However, there was a pulsating mass under the trapezius muscle and just above the outer half of the clavicle. Over this mass a slight thrill could be felt and a definite bruit heard.

September 14, five and a half months after discharge from the hospital, the patient returned for observation. He had been working, was able to wear a high collar and felt generally well. The swelling had increased somewhat in size; the thrill was more pronounced and the bruit louder. Firm pressure just above the middle of the clavicle again stopped the signs of an arteriovenous aneurysm.

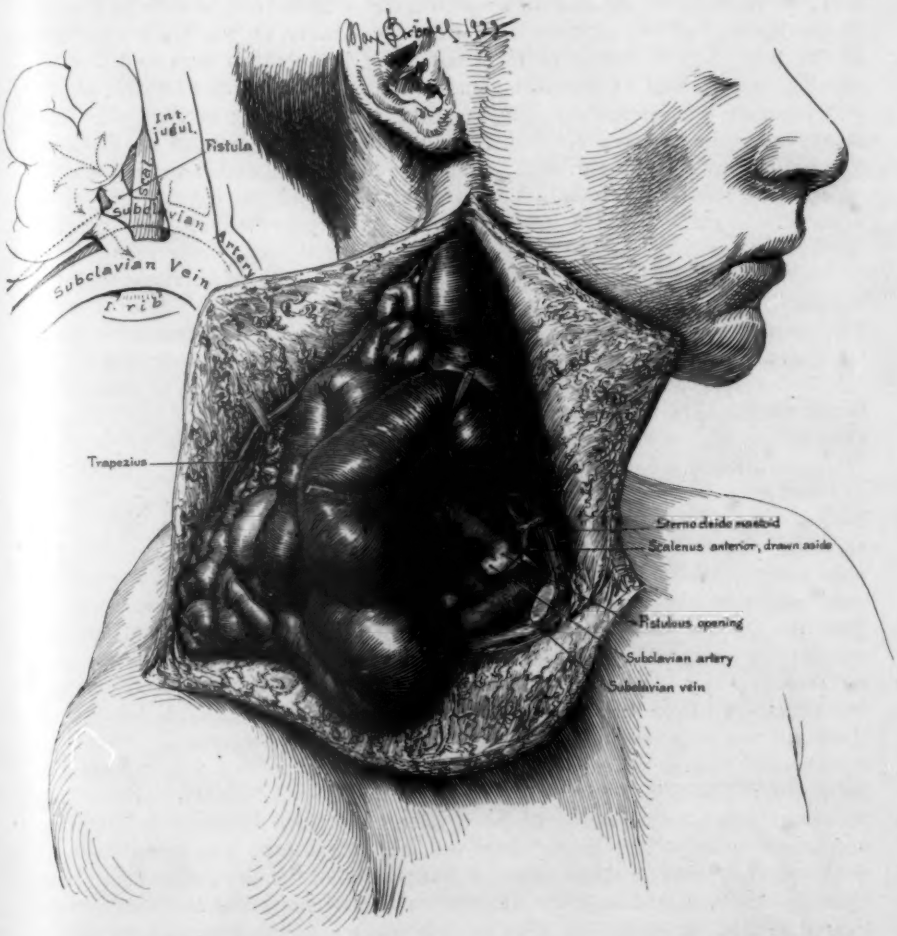

Fig. 12 (Case 30).—Congenital arteriovenous aneurysm; the fistula is between the subclavian artery and veins.

May 17, 1920, fourteen and a half months after the first operation, the patient returned to the hospital for the second. The aneurysm had increased rather rapidly during the previous six months (Fig. 11) and pulsated very strikingly. The area of telangiectatic vessels below the right clavicle persisted. The skin of the entire right back was slightly bluish, and directly beneath it numerous superficial tortuous pulsating vessels could be seen. These were particularly pronounced in the region of the seventh cervical spine. A definite movement

of the entire right chest down to the costal margin could be seen corresponding to each heart beat. The left shoulder drooped about 2 cm. evidently because of paralysis of the trapezius muscle, which was definitely atrophied. The thrill and bruit were more evident than at any previous observation. The thrill could be felt half way down the chest both front and back, while the bruit was audible over the entire chest and neck. On the application of firm pressure above the middle of the clavicle, the signs of an aneurysm disappeared. The only tender spot was over the spine of the scapula where there seemed to be some definite erosion of the bone. The radial pulse was decidedly weaker on the right side than on the left. Again, studies of the heart made by roentgen rays and electrocardiograms as well as physical signs indicated that it was normal.

Operation was performed May 28, 1920, by Dr. Heuer and myself. The operation again required six hours and was equally as difficult as the first. The entire clavicle was removed. After a prolonged dissection the innominate vessels, the subclavian vessels, the carotid artery and the jugular vein were exposed. In the subclavian vein the thrill was very pronounced, and through its thin wall a mixing of arterial with venous blood was plainly seen. Compression of the subclavian vein just where it crossed the first rib obliterated the thrill, but did not affect the pulsation in the great mass of dilated vessels. The operation can best be followed by referring to Figure 13, where the various steps are numbered in sequence. The jugular vein (1) was divided. The subclavian vein was ligatured in two places (2 and 3). Next, a connection between the subclavian vein and the aneurysmal mass was divided (4). Before this bridge was divided the blood through its wall seemed to be entirely arterial. Step 4 permitted an exposure of the subclavian artery, which we followed centrally until we discovered the large fistula. This was just behind the outer edge of the scalenus anticus muscle. In trying to get a little better exposure of the fistula, we got into trouble with a sudden sharp hemorrhage, apparently from the thyroid axis. Before extricating ourselves from this difficulty, we had placed ligatures 5, 6 and 7 on the subclavian artery and ligature 8 on the thyroid axis. During these procedures, there were several sucking sounds indicating that we had opened the pleura. The rent, however, was not seen. At this stage the patient's pulse was 160; it had risen rapidly during our efforts to control the bleeding. There was very little loss of blood, and the rapid rise in pulse must have been due to the firm pressure we exerted in the cervical region and to the pneumothorax, for in a very few minutes the pulse dropped back to about 120. Next, ligatures 9 and 10 were placed. This procedure completely stilled the aneurysm. All small bleeding points were carefully transfixed and ligated with silk, and the wound was closed without drainage. It should be stated that the first portion of the subclavian artery was ligated with tape, and that all other large vessels including the fistula were ligated with heavy black silk. The clavicle was not replaced because we feared that its presence would greatly enhance the chances of a wound infection, particularly as the wound had been so long exposed to the air. The subclavian artery proximal to the fistula was definitely dilated.

At the completion of the operation the patient's face was normal. During our manipulations around the vagus, the anesthetist reported that the right half of the face was flushed. The arm was a little cyanotic. No radial pulse could be felt at the right wrist; at the left, it was very good.

In the ward, the right arm was elevated and massaged centrally every fifteen minutes. Two and one-half hours after the operation the patient was conscious and in good condition. The right arm was a little cyanotic and much colder

than the left. The right pulse could not be felt. There was already a little edema of the right arm, which measured above the elbow 5 cm. more than the left. At that time, there was no edema of the forearm or wrist. Five and a half hours after the operation, the arm was not so cold, and it had improved much as the finger nails indicated. The right forearm had increased 1 cm. since the previous observations; other measurements were the same. Ten and one half hours after the operation there was no cyanosis, and the circulation of the right arm appeared to be as good as that of the left. Sensation had returned to normal; in the previous hours, he had complained of the right hand and arm feeling numb. The swelling of the arm and forearm had

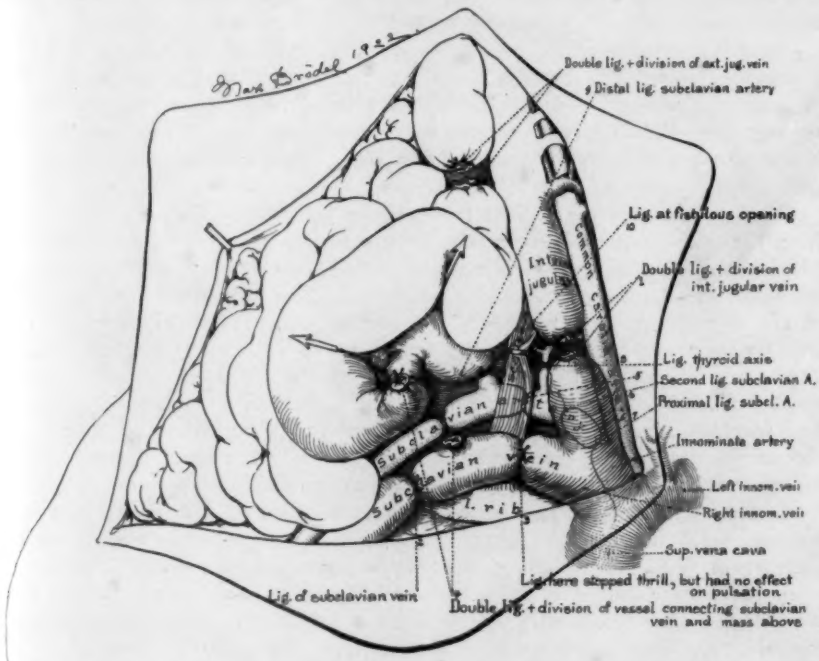
Double lig. + division of ext. jug. vein
9 Distal lig. subclavian artery
Lig. at fistulous opening
10
Double lig. + division of int. jugular vein
1
Lig. thyroid axis
8
Second lig. subclavian A.
6
Proximal lig. subcl. A.
5
Innominate artery
Left innom. vein
Right innom. vein
Sup. vena cava
Lig. there stopped thrill, but had no effect on pulsation
Lig. of subclavian vein
Double lig. + division of vessel connecting subclavian vein and mass above

Fig. 13 (Case 30).—The operation as it was completed; the ligatures are numbered in the order of their application.

each decreased 1 cm. For the last hour there had been almost continuous tetanic contractions of the muscles of the forearm. The right arm still felt colder than the left.

On the day after the operation, the tetanic muscular contractions had ceased, there was slight active hyperemia of the right hand, the edema was not increased. From this time on there was no anxiety about the circulation of the right arm; the edema gradually disappeared, and the color remained good.

By means of thermometers careful observations were made on the surface temperature of both arms. For the first two days records were made every three or four hours and after that twice a day. After forty-eight hours the surface temperature of the right upper arm remained practically the same as the left. However, the right forearm remained usually a little colder than the left. At no time was the right warmer than the left. An interesting

observation was the striking reduction in the surface temperature of one area about 8 cm. in diameter on the outer side of the forearm just below the elbow. The temperature of this spot remained lower, even when the rest of the arm was normal in temperature.

May 30, two days after operation, the patient complained of pain about the heart. The dressings were removed. There was a large pneumothorax on the right side; the heart was displaced upward and to the left, and the right diaphragm was apparently inactive. However, it was not necessary to aspirate the right chest, for the air was rapidly absorbed, allowing the heart to return to its normal position in a few days. A roentgen-ray examination, June 15, still showed a partial pneumothorax and some fluid in the right pleural cavity; the diaphragm was in its normal position.

On June 15, a thrombosis of the superficial veins of the right arm to the elbow was noted; this process did not extend any further. The patient was discharged twenty-four days after the operation. There was no evidence of an aneurysm. The upper right arm and forearm were 2.5 cm. larger than the left. The right radial pulse could not be felt. There was still a little pneumothorax. The arm was placed in a sling because of the absence of the clavicle.

On Aug. 21, 1920, the patient returned for observation. He had been away from the hospital two months. The aneurysm was inactive and disappearing. The right radial pulse was still not palpable. There was a slight dilatation of the veins about the right shoulder and chest. The tenderness over the spine of the scapula was nearly gone. The surface temperature of the right arm was the same as that of the left; the localized cold area was not present. There was a considerable drooping of the entire right shoulder. The right pupil remained contracted and the slight ptosis of the right upper lid persisted. The roentgen rays showed that the heart was in its normal position and that the pneumothorax had disappeared. The clavicle had reformed except for a false joint at its middle. A plaster cast was applied.

October 15, the cast was removed. The non-union of the clavicle persisted, but was much improved. The slight ptosis of the right upper eyelid and the contracture of the pupil were present. The aneurysm was gone. The dilated veins about the shoulder had disappeared. The right arm was normal. A very weak right radial pulse could be felt, but not sufficiently well to make counting possible. A shoulder brace was advised instead of a cast.

By Aug. 20, 1921, the patient was well and working.

June 1, 1924, the patient was well, and no evidence of the aneurysm existed. He had been granted a life insurance policy.

Case 31.—A woman, white, aged 35, was admitted to the Johns Hopkins Hospital, May 21, 1921, complaining of varicose veins. The family and past histories had no bearing on the present condition, which was almost certainly congenital. At the age of 5, a slight fall had resulted in a large hematoma forming about and below the right knee. She was taken to a surgeon in Kansas City, Missouri, who had assured the mother that there was no serious trouble. At that same time the surgeon noted that the right leg was longer than the left. In due time, the ecchymosis disappeared, and there was no further trouble until at the age of 11, when she suffered from an infected wound on the forehead. During this infection, she was troubled with "aches and cramps" in her leg and it had to be bandaged; it was not swollen. Between the ages of 11 and 21, she had a few attacks of tonsillitis; each attack was associated with pains and aches in her legs. Sometime during this period the veins enlarged and began to pulsate, and the skin of the leg became a

bluish color. At 22, she had diphtheria and was forced to stay in bed for eight weeks because of great trouble with her leg; the veins became much enlarged, and the leg was bandaged. From this time until she was 30 years old, she had very little trouble with her leg; she was able to work, take exercise, and dance. Occasionally she spoke of her knee during this time as being stiff and "rheumatic." From the age of 21, she had always worn a bandage on her leg. At 30, another severe attack of diphtheria was followed by a long period of trouble. She was in bed six months, with the leg elevated at an angle of 45 degrees, and the pain was so severe that sedatives were frequently

Fig. 14 (Case 30).—The result June 1, 1924; there is no evidence of a fistula, and the clavicle has reformed.

necessary. She was then operated on by Dr. Lewis at the Kelly Sanitarium in Baltimore. Many of the veins were removed from above and below the right knee. I was told by the surgeon that the operation was very difficult. After this operation, she was able to get around fairly well although she suffered considerable pain, for the next five years. Seven weeks before her admission to the Johns Hopkins Hospital she again had to go to bed because of pain in her leg (at this time there was no general disease or infection that precipitated her trouble). She also noted for the first time that "her leg refused to empty itself of blood during the night." During these seven weeks she had her tonsils removed, but this brought about no definite improvement in the condition of her leg.

For several years she had observed the appearance of pigmented spots in the skin of her leg, but she could not associate these with the occasional points of stinging pain that she had felt. The pulsation of the veins had gradually become more pronounced. She had noticed that walking gave her less discomfort than simply permitting the leg to hang down.

Examination (Fig. 15).—From the toes of the right foot to just above the knee, the subcutaneous space was filled with large pulsating vessels. These

Fig. 15 (Case 31).—Cirsoid aneurysm or congenital multiple arteriovenous fistulas within the right tibia; the large blood vessels of the right leg, its pigmentation and increased length may be seen.

were most marked from the ankle to the knee. The skin in many small areas showed evidences of subcutaneous hemorrhages. Judging from the levels of the patellas, the right leg was 1 cm. shorter than the left, but judging by the internal malleoli it was 4 cm. longer. The surface measurements of the legs were as follows:

Anterior superior spine to internal malleolus: right, 86.5 cm.; left, 80.5 cm.
Bryant's line: right, 5 cm.; left, 4.5 cm.
Length of femur (trochanter to external condyle): right, 43 cm.; left, 42.5 cm.

Tibia: right, 40 cm.; left, 35.5 cm.

This great difference in the length of the two legs was further confirmed by taking a roentgen-ray plate of both entire legs and then measuring the pictures of the bones. In the taking of this picture, the legs were placed in corresponding positions and the tube centered directly above and midway between the knees. These measurements were:

Femur (trochanter to joint): right, 46.5 cm.; left, 44.75 cm.
Tibia: right, 43.5 cm.; left, 37.75 cm.
Fibula: right, 41.5 cm.; left, 36.75 cm.

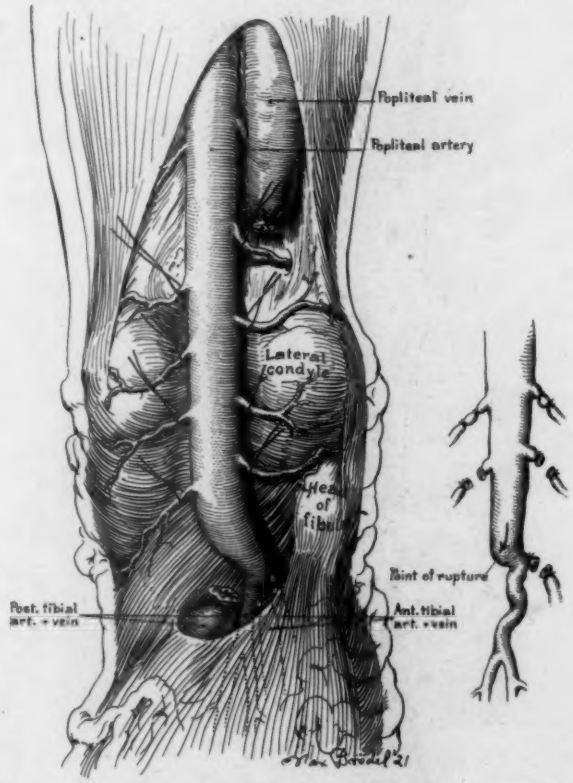

Fig. 16 (Case 31).—The popliteal vein was excised. All branches of the popliteal artery were ligated except the posterior tibial and two small branches in the upper part of the popliteal space. Division of the anterior tibial artery freed the popliteal artery so that it tended to kink. Four days later, rupture of this artery occurred; the arterial wall was as thin as that of a vein.

According to a roentgen-ray report made by Dr. F. H. Baetjer, the right femur, tibia, and fibula were much larger than the left. There was a slight coxa valga of the right femur. There were vacuolated areas in the tibia and changes in the soft tissues which he was unable to diagnose. In spite of the great difference in the length of the two legs, the patient walked without a limp. The surface temperature of the right leg was 1 degree higher than the left in the groin and 4 degrees higher just below the knee, while between the

toes it was the same on the two sides. The circumference of the right leg was from 2 to 3 cm. greater when the limb was dependent than when it was elevated. When it was elevated, the veins partially collapsed, having mottled depressions which seemed to extend into the surface of the tibia. It appeared as if the pulsating veins had eroded the bone. When the leg hung down, the veins became distended and there was marked congestion and cyanosis. The right

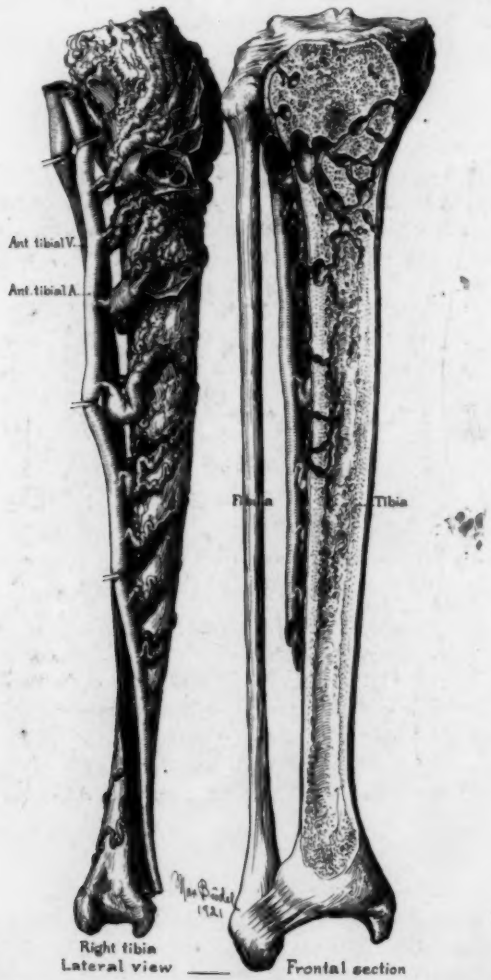

Fig. 17 (Case 31).—Cirsoid aneurysm of the tibia; the appearance externally and on cross section. The abnormal communications between the arteries and veins were within the tibia; the dilated and tortuous branches arising from the anterior tibial artery may be noted.

femoral and popliteal arteries were huge, the former being two and a half times the size of the left. The right popliteal artery measured roughly 4 cm. in diameter. A thrill was present all about the knee and over the femoral artery. A loud, continuous bruit could be heard over the entire right leg and over

the course of the iliac vessel. The thrill and bruit were most marked over the point where the anterior tibial artery emerged between the tibia and fibula. Occlusion of the popliteal artery did not, however, cause the bruit to disappear completely. The size of the popliteal artery and the force with which it was beating made one hesitate to press too firmly on it; besides, firm pressure over the popliteal artery was very painful. The pulse in the right posterior tibial and dorsalis pedis arteries was two-thirds as strong as the pulse in the left foot. The blood pressure in the right leg was 160, (the diastolic could not be determined on account of the bruit). In the left it was: systolic, 140; diastolic, 65. In both arms it was: systolic, 115; diastolic, 65. From physical, roentgen-ray and electrocardiographic studies, the heart appeared to be normal.

Fig. 18 (Case 33).—Congenital pulsating exophthalmos. (Age of patient, 16 years).

It was the impression in this case that there was an arteriovenous fistula between the anterior tibial artery and vein.

Operation.—Operation was performed May 25, 1921, by me. A longitudinal incision, about ten inches (25.4 cm.) long, was made in the popliteal space. The popliteal vein was 2.5 cm. in diameter, pulsated and evidently contained arterial blood which was easily seen through its extraordinarily thin wall. The artery appeared to be nearly as large. A thrill and a bruit[10] were very evident in both vessels. Around the artery in the uppermost part of the popliteal

10. For this operation, a stethoscope had been sterilized in order that the operator might listen directly into the wound and thus judge the effect of his operative procedures.

space a Hoffman clamp was placed; about the vein, a tape, so that at any time these vessels could be occluded. The anterior tibial artery was ligated and divided. This step caused almost complete disappearance of the thrill, but the bruit persisted. In attempting to ligate the two large anterior tibial veins, a small rent was made in one of the vessels; from it came arterial blood in great force. Even occlusion of the popliteal artery did not lessen very greatly the tendency of this point to bleed. An assistant held his finger on the bleeding point until I excised the entire popliteal vein. This permitted the infolding of the tibial veins into the opening of the interosseous membrane. A piece of muscle was placed in this opening, and the heads of the posterior tibial muscle were sutured over it. This controlled the bleeding. Next, we proceeded to ligate the branches of the popliteal artery, testing with the stethoscope the effect that each ligation had on the bruit. It was necessary to ligate all of the genicular branches (Fig. 16), except the two superior, before the bruit disappeared. The ligations of the arterial branches were made from below upward, and at each ligation the popliteal artery became smaller.

Fig. 19 (Case 33).—The condition of the right eye at the ages of 3 months and 3 years.

At this stage, the operator expressed a belief that the entire popliteal artery should be removed. The division of the anterior tibial artery had so freed the popliteal artery that it seemed too long for the space it traversed. As a result each pulse caused a kinking of the vessel at the point of ligation of the anterior tibial artery. One could not look at this phenomenon without fearing that the vessel would be worn in two at the point of kinking, especially as the arterial wall was itself so unusually thin. However, the advice of the audience prevailed; and the operation was terminated as shown in Figure 16, the muscular attachments, subcutaneous fascia and skin being closed by interrupted fine silk sutures.

The operation required about six hours, but the patient left the table in good condition, with a pulse rate of 80. There was practically no loss of blood. At the completion of the operation no thrill was present anywhere in the right leg.

Postoperative Course.—The patient reacted well from the long anesthetic. After forty-eight hours a small window was cut in the front of the cast just below the patella. The pulsation was still present in the veins although it was much reduced, and a bruit was audible. No thrill could be felt; the bruit was not audible over the femoral vessels. Her condition remained good until the fourth day when she felt a severe pain in the popliteal space; the pulse

rose to 120, and the temperature to 102 degrees. For the next four days she continued to have severe pain, pulse and temperature remaining about the same. She complained a great deal of a sensation of tightness, which splitting of the cast did not relieve. May 30, five days after the operation, no pulse could be felt in the foot. June 2, the pain was most intense, and within a few hours the foot became cold. Gangrene was beginning. The leg was amputated at the middle of the thigh within two hours after the onset of gangrene in the foot was positively indicated.

Following the amputation, the patient made a satisfactory recovery. It was interesting to note the rapid decrease in the size of the femoral artery. In the first month after amputation the femoral vessel in the stump decreased one-half in size; afterwards it decreased more slowly.

Examination of the specimen (Fig. 17) revealed a large blood clot filling the popliteal space; it had dissected down between the gastrocnemius and soleus muscles. There was a big opening in the popliteal artery just opposite the stump of the anterior tibial artery and at the site of the kinking noted at the time of operation. The anterior tibial artery was large. Its branches ran directly into large openings in the cortex of the tibia, and many of these branches contained little saccular aneurysms about the size of a cherry. Likewise, large veins emerged from openings in the cortex of the bone. Outside the bone no fistulas between the arteries and veins could be demonstrated. Within the tibia were large vascular cavities, lined with delicate endothelium. By injections and dissections it was easy to prove that these large spaces connected directly with both arteries and veins. The histologic study of the arteries and veins showed that the walls of both were unusually thin and delicate.

Case 33.—A white boy, aged 16, was admitted to the Cincinnati General Hospital Oct. 30, 1923, because of a fractured leg. On general physical examination, it was observed that he had a right pulsating exophthalmos (Fig. 18). The history of this condition revealed that the boy was born with a protruding right (Fig. 19) eye which has been slowly becoming more prominent. This condition had in no way interfered with the patient's health, unless it is responsible for his mental retardation. The patient was also born with a club foot; this condition was corrected at the age of 4 months.

The eye pulsated strongly. This pulsation could be markedly reduced by pressure on the right common carotid artery and would disappear completely if both carotids were compressed at the same time; the exophthalmos also decreased. No thrill or bruit could be detected in the head or over the great vessels of the neck. The right pupil was irregular and eccentrically placed. Vision was very good, and the visual fields were normal. Both fundi were normal except for the dilated veins in the right eye. A roentgen-ray examination of the head revealed no abnormality. Operation was refused. The case was a good example of congenital pulsating exophthalmos probably produced by an intracranial angioma or cirsoid aneurysm.

SUMMARY

Thirty-three cases of abnormal arteriovenous communications are reported in this paper. Of these, twenty-seven were acquired and six were congenital. The locations of these communications were: femoral,

eight; intracranial, six; subclavian, five; popliteal, three; carotid, two; head, four; hand, two; lip, one; eyelid, one; tibia, one.

Twenty-six patients were cured; three were improved; two were not treated, and two died.

SPLENIC ANEMIA

A STUDY OF END-RESULTS WITH AND WITHOUT SPLENECTOMY, BASED ON THIRTY-FIVE CASES *

EDWARD M. HANRAHAN, JR.

BALTIMORE

This study was made primarily to investigate the end-results following splenectomy in a group of cases which were thought to show clinically the typical features of that form of secondary anemia with splenomegaly known as splenic anemia, or Banti's disease. Splenectomy has been performed in the Johns Hopkins Hospital for many different conditions. These conditions include rupture of normal and acutely swollen spleens, neoplasms, both primary and secondary, Gaucher's disease, leukemia, infectious splenomegaly of malarial, tuberculous or syphilitic origin, pernicious anemia, hemolytic jaundice and splenic anemia or Banti's disease. Of these conditions, it was found that the last three mentioned offered difficulty in accurate classification. It is not desired at this time to investigate the end-results following splenectomy in pernicious anemia or in hemolytic jaundice, since this has been shown by many authors, including Krumbhaar,[1] Mayo,[2] Moynihan,[3] Elliott and Kanavel,[4] but rather to investigate the end-results in that syndrome defined by Osler [5] in his second paper in 1902. Osler advocated the term splenic anemia for that chronic affection, probably an intoxication of unknown origin, characterized by a progressive enlargement of the spleen, which cannot be correlated to any known cause such as malaria, leukemia, cirrhosis of the liver, etc. (primary splenomegaly); anemia of the chlorotic type (leukopenia); a marked tendency to hemorrhage, particularly from the stomach, and in many cases having a terminal stage with cirrhosis of the liver, jaundice and ascites (Banti's disease).

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* From the Department of Surgery, Johns Hopkins Hospital.

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In restudying the cases diagnosed as splenic anemia, two facts became apparent: first, that while pernicious anemia and hemolytic jaundice may be considered as distinct clinical entities, there are atypical cases that show many characteristic features of both, and there are gradations linking up the typical splenic anemia of Osler with these atypical cases, constituting a group which is not typical of any one of the three; second, that there are many cases reproducing with remarkable accuracy the picture described by Osler, except in the question of unknown etiology. These may be directly or indirectly connected with a previous history of malaria, tuberculosis, syphilis, miscellaneous chronic infections or rickets,[6] particularly in children to whom any state of malnutrition, if protracted, may lead to enlargement of the spleen.

It was decided, therefore, to include in this series those cases usually offering most difficulty to the clinician. They may be divided into three classes: first, those cases usually acute, which do not show the characteristic or typical features of pernicious anemia, hemolytic jaundice or splenic anemia, which may represent a more acute stage of the disorder as described by Osler and which are being reported with increasing frequency, particularly by German writers;[7] second, typical splenic anemia, and third, splenic anemia, which may be correlated to some known cause. Osler rejected many cases of the latter group for the reason that the sequences so characteristic of splenic anemia are not seen. In 1916, he felt that the spleen itself was the seat of the disease because of the fact that complete recovery follows its removal.[8] On this basis, he distinguished several forms of splenomegaly from splenic anemia on the grounds that in the former the condition is not primary; but, in studying such a group, the end-result does not prove that this is the case. Complete recovery does not follow splenectomy in every case of splenic anemia, as he described it, nor does splenectomy fail to relieve the condition in those cases in which he did not believe the condition to be primary. Recovery, apart from accidents, depends in both types upon the activity of the underlying disease process. I have

6. Aschenheim, E., and Benjamin, E.: Ueber Bezierhungen der Rachitis zu den hematopoetischen Organen, I, Die rachatische Megalosplenie (Anemiae pseudoleucaemica infantum), Deutsch. Arch. f. klin. Med. **97**:529, 1909. Evans, F. A., and Happ, W. M.: Secondary Anemia of Infants. A Study of So-Called Infantile Splenic Anemia or Anemia Infantum Pseudoleukaemica, Bull. Johns Hopkins Hosp. **23**:1, 1922.

7. Moffit, H. C.: The Function of the Spleen with Particular Reference to Hemolysis and the Hemolytic Anemias, Boston M. & S. J. **171**:289, 1914. Morawitz, P.: Ueber die Indikationen des Milzextirpation, Ber. klin. Wchnschr. **1**: 769-772 (April 15) 1922.

8. Osler, Sir W.: Diseases of the Spleen, Principles and Practice of Medicine, Ed. 8, New York, D. Appleton & Co., 1916.

come to the conclusion that splenic anemia is not a disease entity such as is so sharply defined by Osler or Banti,[9] but that it is a syndrome that may be brought about by various causes. Krumbhaar [10] recognizes that, since negative methods are the only ones at present available for diagnosing Banti's disease, many cases of splenomegaly due to syphilis, cirrhosis, portal phlebitis and similar causes are undoubtedly included in any study of this condition, and it is especially hard to distinguish them when successful removal of the spleen in the latter group also results in improvement. Moynihan [3] states that if a case clinically and pathologically has a known causation it is not Banti's disease, and also, that the fact of utmost significance in connection with its causation is that it is arrested by splenectomy. This study indicates that the latter is not necessarily true, and as regards etiology, there is no existing evidence that this disease process may not be directly or indirectly connected with at least one causative factor.[11] Moynihan also says that the diagnosis is usually made only by microscopic examination of the spleen and inspection of the liver. It must be remembered, however, that the microscopic appearance of the spleen and the gross appearance of the liver is often accurately reproduced by any one of the various diseases or etiological factors which may be correlated to this disorder. Chaney,[12] in his study of the Mayo clinic material, shows how little value is to be placed on the microscopic pathology of the spleen in the differential diagnosis of this condition.

In many of the earlier cases of both splenic anemia and hemolytic jaundice, the fragility of the red blood cells was not determined. Consequently, there may be considerable overlapping of these two groups, particularly when one is dealing with the acquired form, in those cases in which the microscopic appearance of the spleen was not definite. The leukemias represent another group of disorders presenting some difficulties as regards elimination. In the aleukemic stage, many of the typical findings of splenic anemia may be represented. The inclusion of these in this series would considerably affect our interpretation of end-results since not quite the same results are obtained with splenectomy following radiation of leukemic splenomegalies as reported from the Mayo clinic. Therefore, all cases showing glandular enlarge-

9. Banti, G.: Splenomegalie mit Lebercirrhose, Ziegler's Beiträge **24**:21, 1898.

10. Pearce, R. M.; Krumbhaar, E. B., and Frazier, E. H.: The Spleen and Anemia, Philadelphia, J. B. Lippincott Company, 1918.

11. Osman, A. C.: Splenic Anemia and Chronic Splenomegaly, Guy's Hosp. Rep. **71**:19-49 (Jan.) 1922.

12. Chaney, W. C.: Splenic Anemia: A Clinical and Pathological Study of Sixty-Nine Cases (Mayo Thesis), Am. J. M. Sc. **165**:856-875 (June) 1923.

ment, in which the blood examination did not definitely exclude leukemia, are not included.

The end-results obtained in this series following splenectomy for pernicious anemia show that this is practically a fruitless procedure. Between 1913 and 1916, following Eppinger's lead,[13] there was some enthusiasm in this hospital over this operation, and ten splenectomies were performed for this condition. The results as seen now are significant. Of the ten patients, three died within forty days of the operation, and five died after periods of from four months to three years, or after an average period of fourteen months; two could not be located.

For further information, it was felt that a comparison of the end-results of a similar group not subjected to splenectomy would be very valuable. In selecting suitable cases for this study, the same criteria were used as in selecting those operated on, with the difference that, except in two cases, no idea of the microscopic appearance of the spleen was known. The comparison, for these purposes, was legitimate, inasmuch as they were clinically, in all other respects, cases of typical splenic anemia.

Thirty-five examples of splenic anemia are reported. Of this number, twenty-two patients were subjected to splenectomy, while the remainder, thirteen, with the exception of two, were not operated on. Of the two exceptions, one was operated on for a femoral hernia, and a small piece of spleen was removed through a laparotomy for microscopic study. Splenectomy was attempted but abandoned in the second after a small splenule had been excised for study. These thirty-five cases have been studied for the purpose of determining the presence of any etiologic factors, the characteristic or average blood picture of the condition, the possible bearing of certain features on the prognosis, and both the immediate and late affects of splenectomy. They were also classified according to the duration of symptoms, and the end-results studied on this basis. The "Bowman Case" previously reported by Osler,[5] by Cushing and MacCallum [14] and often referred to in literature, has been restudied, and the results of an examination twenty-five years after splenectomy are given in detail. As far as it is known, this is the longest "cure" reported in this condition.

REPORT OF CASES

CASE 1.—J. F. S., a white man, aged 50, was admitted to the hospital, Nov. 30, 1918. This patient had had malaria when a young man but had had no

13. Eppinger, H.: Zur Pathologie der Milzfunction, Berlin klin. Wchnschr. **50**:1509, 1572 and 2049, 1913.

14. Cushing, H., and MacCallum, W. G.: Two Cases of Splenectomy for Splenic Anemia and a Report of the Pathological Changes in Splenic Anemia. Arch. Surg. **1**:1 (July) 1920.

symptoms for twenty years. For twelve years, since 1906, he had noticed sensitiveness on pressure on the left side of the abdomen. In February, 1918, eight months before admission he began to be noticeably constipated, and noticed the lump in his side. There had been tenderness in the left abdomen for twelve years, but he had been symptomless for eleven years, when splenomegaly, accompanied by constipation, became definite.

On examination, his skin was sallow and yellowish. There was no general glandular enlargement, but the splen was found enlarged to the umbilicus, and the liver 5 cm. below the costal margin. Examination of the urine was negative for urobilin, and showed 77 per cent. phenolsulphonephthalein excretion for two hours. The blood Wassermann test was negative both before and after a provocative dose of arsphenamin. Slight secondary anemia with leukopenia was present. The differential blood count was negative. The duration of definite symptoms was eight months.

The blood test revealed: red blood cells, 4,500,000; hemoglobin, 83 per cent.; white blood cells, 4,400; color index, 0.92. The differential blood count showed: polymorphonuclears, 60 per cent.; polymorphonuclear eosinophils, 2 per cent.; polymorphonuclear basophils, 1 per cent.; lymphocytes, 29 per cent.; large mononuclears and transitionals, 8 per cent. Splenectomy was not advised. The patient was discharged from the hospital, and died twenty months after.

Case 2.—Mrs. K. H., a white woman, aged 46, was admitted to the hospital, Aug. 11, 1910. The patient presented a history of typhoid fever at the age of 14, and yellow fever at the age of 18. Four years before admission she had a "nervous breakdown" with anemia, which inaugurated the present state of poor health. She complained of weakness and indigestion. Her appetite had been poor and she had been short of breath on exertion. Examination showed the spleen to be 4 cm. below the costal margin. The liver was not enlarged. Examination of the heart was negative. The gastric contents of the stomach contained no free hydrochloric acid, and the total acidity was 10 per cent. The result of the Wassermann blood test was negative.

On admission, the blood examination revealed: red blood cells, 3,740,000; hemoglobin, 44 per cent.; color index, 0.60; white blood cells, 7,200. The differential blood count showed: polymorphonuclear, 52 per cent.; polymorphonuclear eosinophils, 1 per cent.; polymorphonuclear basophils, none; lymphocytes, 22 per cent., and large mononuclears and transitionals, 20 per cent. Moderate anisocytosis and poikilocytosis. No nucleated forms were seen. When she was discharged, November 17, examination revealed: red blood cells, 5,150,000; hemoglobin, 75 per cent.; white blood cells, 7,900.

Splenectomy was not advised. The patient was treated by general measures and had several transfusions. Dr. Vincent Bonelli of Vicksburg, Miss., examined this patient's blood, May 10, 1923, and reported 4,300,000 red blood cells; hemoglobin, 90 per cent.; color index, 0.95, and 5,625 white blood cells. She is in good health.

Case 3.—Mrs. H. A. M., a white woman, aged 26, was admitted May 29, 1912. The history in this case was negative. The duration of symptoms before admission had been one year. For three or four years the patient had had shortness of breath, but no abdominal symptoms. During the summer of 1911, she had anemia and sore gums. Examination showed the teeth to be in poor condition. The tongue was smooth, and to some observers suggested pernicious

anemia. There was no general glandular enlargement. The spleen was readily palpable at the costal margin. The liver was not felt. There was no jaundice or ascites, and the Wassermann reaction was negative.

The blood examination revealed: red blood cells, 3,700,000; hemoglobin, 50 per cent.; color index, 0.87; white blood cells, 7,800.

The patient remained in the hospital four days. She was in poor health when she was heard from in April, 1923.

CASE 4.—N. P. H., a white man, aged 38, was admitted, April 3, 1913. This patient gave a history of malaria fifteen years before admission, the attack lasting three or four months. He had had a gonorrheal infection at the age of 25. His health has been good until two years ago, when he noticed a beginning loss of weight. There had been pain about the hips for six months. Examination revealed the fact that he was pale and slightly yellowish, with pigmentation of the exposed skin. There was sacro-iliac tenderness which was not thought due to the sacro-iliac joint. The spleen was felt 5 cm. below the costal margin, and the liver 2 cm., in the midclavicular line. Gastric analysis showed 2 per cent. free hydrochloric acid, and the total acidity was 12 per cent. The Wassermann reaction was negative.

Examination of the blood showed: red blood cells, 5,488,000; hemoglobin, 70 per cent.; color index, 1.02; white blood cells, 4,600. On discharge, the blood showed: red blood cells, 4,640,000; hemoglobin, 70 per cent.; color index, 0.70; white blood cells, 6,000. The differential blood count was: polymorphonuclears, 57.5 per cent.; polymorphonuclear eosinophils, 2 per cent.; polymorphonuclear basophils, none; lymphocytes, 13.5 per cent.; large mononuclears and transitionals, 16 per cent.; myelocytes, 10 per cent.

While the patient was in the hospital there was a slight irregular fever and the condition was thought to be an early Banti's disease. He was discharged April 18, and died in 1914.

CASE 5.—L. D., a white man, aged 46, was admitted, Nov. 17, 1914. There was a history of malaria, fifteen years before admission, which, according to the patient, inaugurated the splenomegaly. The general health had been good until five months before admission, when the daily number of stools increased. The patient had been able to work, but had steadily become weaker. There were no gastric hemorrhages.

Examination showed marked pyorrhea and dental caries. Lymph glands were generally palpable, and there was a benign rectal stricture. The costal angle was much widened, and small dilated veins were noticed on both sides of the abdomen. There was a marked splenomegaly, possibly nodular, which extended to the iliac crest and nearly to the umbilicus. The liver was not enlarged, and there was slight, shifting dulness. It was probably a case of splenomegaly, possibly malarial in origin, although syphilis, in spite of the negative Wassermann test, was considered. There was slight secondary anemia, with a color index over 1, and the liver was involved.

The blood examination showed: red blood cells, 4,184,000; hemoglobin, 80 per cent.; color index, 1.04; white blood cells, 5,520, of which there were: polymorphonuclears, 80 per cent.; polymorphonuclear eosinopils, 1 per cent.; polymorphonuclear basophils, 2 per cent.; lymphocytes, 18 per cent., and large mononuclears and transitionals, 19 per cent.

The Wassermann reaction was negative. Stool examination revealed the presence of trichomonas ova. Splenectomy was recommended but refused. The patient was discharged December 3, and was not heard from after that date.

CASE 6.—A colored woman, aged 44, was first admitted Oct. 12, 1899. The patient's illness dated from July, 1899. She had been weak and had lost her health caring for two sick sons, one of whom had tuberculosis. She complained of weakness and left-sided numbness, constipation alternating with diarrhea, and night sweats covering a period of several months. She was frail, appeared anemic, and the pulse was of low tension. Both the spleen and liver were enlarged; the spleen was felt 4 cm. below the costal margin and was slightly tender. No ascites was demonstrated.

Examination of the blood revealed: red blood cells, 1,540,000; hemoglobin, 23 per cent.; color index, 0.70; white blood cells, 3,300; polymorphonuclears, 58 per cent.; polymorphonuclear eosinophils, 1 per cent.; polymorphonuclear basophils, none; small lymphocytes, 36 per cent.; large mononuclears and transitionals, 2 per cent. There was marked anisocytosis and poikilocytosis, and a few nucleated forms were seen.

The case was diagnosed as a rapidly progressing anemia with splenomegaly, ending in death after two years. It was possibly an acute anemia as opposed to anemia splenica chronica of Osler.

CASE 7.—B. S., a white woman, aged 34, was admitted, July 13, 1902. The onset had occurred six months before admission, with weakness and palpitation of the heart on any exertion, and anorexia. The patient suffered from headache and lack of appetite. There was one attack of hematemesis. The shortness of breath has continued and grown worse. The spleen was enlarged and readily palpable just below the costal margin. There was no jaundice nor ascites, and no lymph gland enlargement was present. There was marked secondary anemia with leukopenia.

Examination of the blood revealed: red blood cells, 2,072,000; hemoglobin, 30 per cent.; color index, 0.72; white blood cells, 5,100. The differential blood count was: polymorphonuclears, 61 per cent.; polymorphonuclear eosinophils, 0.7 per cent.; polymorphonuclear basophils, none; small lymphocytes, 30 per cent.; large mononuclears, 6 per cent. There was moderate anisocytosis and poikilocytosis; no nucleated red cells were seen.

The patient was discharged August 7, at her request, with no treatment but rest in bed and improvement in diet. The ultimate result is not known. This case resembles Case 6.

CASE 8.—C. E. C., a white man, aged 28, was admited, June 26, 1905. The onset had occurred ten months before, with attacks of abdominal pain not associated with nausea and vomiting. Eight months before, the patient noticed blood in the stools. For six months, there were intermittent attacks of slight gastric symptoms with poor appetite and the belching of gas. Examination showed an enlarged spleen with nodular masses beneath it. No ascites were demonstrated. The liver was apparently of normal size, and there was no enlargement of the lymph gland. There was slight anemia with slight leukocytosis.

Examination of the blood revealed: red blood cells, 3,984,000; hemoglobin, 65 per cent.; color index, 0.81; white blood cells, 9,600.

Splenopexy was performed, after the finding of an enlarged liver and spleen, and a small splenule 2 cm. in diameter was excised. A counter incision was made, and a gauze drain introduced to stimulate adhesions.

A microscopic examination of the splenule showed an increase in connective tissue stroma. The malpighian bodies were normal in appearance. The pulp was predominantly lymphoid, and the blood spaces were not engorged.

The patient recovered, and was reported well, April 5, 1923.

CASE 9.—M. F. B., a colored woman, aged 48, was admitted, Sept. 29, 1923. This was an interesting example of an apparent Banti's disease of long duration. The patient had previously been admitted to the hospital in 1912, when she was operated on for a femoral hernia, and her splenomegaly was interpreted as Banti's disease. According to her statements, she had had an enlarged abdomen since 1903, for which she had twenty-five paracenteses. Most of these occurred between 1903 and 1906, while only six were necessary between 1906 and 1907. It was after a tapping previous to 1906, that she first noticed the abdominal mass. The last tapping took place in 1917, when large quantities of straw colored fluid were removed. Her history is of interest only in that she had severe chills when she was twelve years old. When she was admitted to the hospital in 1912, her only complaint was the femoral hernia, which was operated on by Dr. George Heuer.

She permitted Dr. Heuer, through a small laparotomy, to excise a small piece of spleen, which was reported by Dr. J. C. Bloodgood as showing the usual changes of Banti's disease. On reexamination of the section of this spleen, the markedly thickened capsule and trabeculae were noted. The pulp was not so cellular as normally, there being a diminution of the lymphoid tissue and a definite increase in the coarse and fine connective tissue framework, with a hyaline change in places. The malpighian bodies were decreased in size, and the vessels were thickened. The blood spaces were not dilated, and pigmentation was not noted. The blood picture at that time showed a mild secondary anemia with a pronounced leukopenia. There were: red blood cells, 4,400,000; hemoglobin, 68 per cent.; color index, 0.7; white blood cells, 1,840, of which there was 60 per cent. polymorphonuclears and 25 per cent. lymphocytes. Examination of the urine was negative.

The patient made an uneventful recovery from the operation, and was discharged untreated as regards her splenomegaly.

In September, 1923, in response to an inquiry, she returned to Baltimore to be treated for a "lump in her breast." This lump had been present for three years, and had increased in size only during the preceding year. It measured 6 by 4 cm. It was firm, elastic and lobulated, not adherent to breast tissue, but suggested being adherent to the skin over a small area. There were no enlarged axillary glands. The spleen was still greatly enlarged, extending 9 cm. below the costal margin. The liver was palpable and the apical systolic murmur often heard in connection with splenomegaly was present. There was no demonstrable ascites. The tumor of the breast was considered benign, but at operation, Oct. 6, 1923, by Dr. W. F. Rienhoff, Jr., it was found to be a colloid carcinoma, and the radical operation was performed. She made an uneventful recovery from this operation. Examination of the blood made at this admission, September 29, revealed: red blood cells, 5,200,000; hemoglobin, 75 per cent.; white blood cells, 2,000. October 30, the result was: red blood cells, 5,120,000; hemoglobin, 75 per cent.; color index, 0.7; white blood cells, 2,280. The differential blood count was: polymorphonuclears, 67 per cent.; polymorphonuclear eosinophils, none; polymorphonuclear basophils, 1 per cent.; lymphocytes, 23 per cent.; transitionals and large mononuclears, 8 per cent. October 31, there were: red blood cells, 4,896,000; hemoglobin, 89 per cent.; white blood cells, 3,640; reticulated red blood cells, 0.09 per cent.; the platelets were reduced; polymorphonuclears, 71 per cent.; polymorphonuclear eosinophils, 4 per cent.; polymorphonuclear basophils, none; lymphocytes, 14 per cent.; transitionals and large mononuclears, 11 per cent. The blood was apparently normal except for leukopenia, and the Wassermann reaction was negative. The urine examined was negative, except for the constant presence

of urobilin. The red blood cell resistance was normal, and there was a definite hypocholesterolemia. The resistance of the erythrocytes was normal in hypotonic salt solution. Hemolysis began at 0.44 and ended at 0.32, figures identical with the normal control.

According to Moynihan's definition [8] this is not an example of Banti's disease, but this conclusion is reached only after eleven years. The disease is not invariably fatal. As regards her splenopathy this woman was better than she was twenty years before. On restudy, it did not correspond to Osler's definition of splenic anemia except in its chronicity, since there were no evidences of its progressiveness. After eleven years, one had a better idea regarding it than observers, seeing it for the first time, had in 1912. It was not typical Banti's disease, but probably a chronic inflammatory splenomegaly. There were some features identifying it with the so-called Columbian spleen, although the only indication of malaria is the history of chills in childhood. Bates [15] believes that this condition is malarial in nature, although the parasites and pigment are absent. Restudy of the section of the spleen does not eliminate Banti's disease. The ascites, so pronounced at the onset, and during the earlier years, might have been due to a twisted splenic pedicle or to other circulatory interference. This case is included here because, in 1912, it was clinically and according to the microscopic appearance of the spleen, diagnosed as Banti's disease; as such, it has a place in a study of the end-results of splenic anemia.

Case 10.—A white man, aged 53, was admitted to the hospital, Oct. 29, 1922. The history began with typhoid fever in 1902, which inaugurated intermittent diarrhea, sometimes with twenty to thirty stools daily. After that time, the patient (a physician) attempted to control the diarrhea wih paregoric and bismuth. In 1906, he developed an accidental chancre of the right index finger, but showed no secondary manifestations. Treatment with mercury was pursued vigorously for the next five years. During that time, the diarrhea continued as before. About 1912, he began to have recurrent attacks of jaundice unaccompanied by pain. In 1916, he had several treatments with arsphenamin, and the Wassermann reaction was said to have been negative. In 1917, after a thorough investigation, his condition was thought to be a beginning of gallstone formation, chronic pancreatitis and splenomegaly. The red blood cells numbered 4,200,000, hemoglobin was 90 per cent., and there were 9,200 white blood cells. There was gastric hypochlorhydria, and the Wassermann reaction was positive. Roentgen-ray treatment of the spleen reduced it markedly in size soon afterward. In 1912, while the patient was in the army, the diarrhea subsided, but the jaundice persisted. In 1921, he developed paroxysmal coughing and marked jaundice, with loss of weight. In July, 1922, three months before admission, the bronchitis and jaundice recurred, the diarrhea and paroxysmal coughing and precordial distress became worse and edema of the lower extremities developed. It is also to be noted that his wife has no living children; of three pregnancies, two children were stillborn and another lived only five days.

15. Bates: Personal communication to Pool, quoted by Pool and Stillman.

On examination in the hospital, he was seen to be pale and sallow. The general nourishment was fair. The conjunctivae were slightly yellow, and the abdomen full and somewhat irregular, with dilated veins to the left of the umbilicus coming upward from the left femoral. The spleen was felt extending 10 cm. from the tenth rib transversely and 7 cm. below the costal margin. The liver was at the costal margin and not particularly hard. Both the stools and urine constantly showed large amounts of urobilin.

Examination of the blood made October 20, revealed: red blood cells, 1,536,000; hemoglobin, 38 per cent.; color index, 1.2; white blood cells, 4,200. November 4, the count was: red blood cells, 2,790,000; hemoglobin, 46 per cent.; color index, 0.7; white blood cells, 4,600. November 9, the result was: red blood cells, 2,340,000; hemoglobin, 45 per cent.; color index, 0.9; white blood cells, 4,000. Blood smears showed marked anisocytosis and poikilocytosis, macrocytes and gigantocytes, nucleated reds, a reduced number of white blood cells, and a color index of 1 per cent. The white blood cells decreased with a slight relative increase in eosinophils. The platelets were markedly decreased. The impression from this was that the condition represented Addison-Biermer anemia. The presence of gigantocytes suggested splenic anemia.

November 9, the patient was transfused. Examination, November 11, revealed: red blood cells, 2,520,000; hemoglobin, 54 per cent.; white blood cells, 3,600; polymorphonuclears, 21 per cent.; polymorphonuclear eosinophils, none; small lymphocytes, 19 per cent.; large mononuclears and transitionals, 8 per cent. The examination, November 16, revealed: red blood cells, 2,670,000; hemoglobin, 60 per cent.; white blood cells, 3,200. That made on November 24, showed: red blood cells, 3,240,000; hemoglobin, 74 per cent.; color index, 1.0; white blood cells, 2,700. There was decreased red blood cell resistance, hemolysis beginning at 0.36 (normal control 0.42) and ending at 0.34 (normal control 0.30). Examination later, after transfusion and treatment, showed normal resistance. The phenoltetrachlorphathalein test for liver function was made, 5 mg. per kilogram (400 mg.) of the dye being given intravenously; this was nearly gone from the plasma in four hours. This was interpreted as showing moderate liver damage, and also as showing that the jaundice was obstructive in type, as jaundice of this degree resulting entirely from parenchymatous change would give a higher reading at the end of the fourth hour period. The Wassermann reaction was negative.

Splenectomy was discussed but the patient deferred his consent and left the hospital. Death occurred about two months after he left the hospital.

Case 11.—B. G., a white woman, aged 40, was admitted Aug. 8, 1923. The complaint of this patient on admission was "weakness, anemia, palpitation and ringing in the ears." She had had typhoid fever at the age of 12, but there was no history of malaria, tuberculosis, syphilis or attacks of jaundice. The onset of her illness, which was preceded by some menstrual difficulty, occurred in March, 1922, and was characterized by parasthesia of the feet, abdominal pain and cramps. Enlargement of the spleen had been noticed since October, 1922, ten months before admission. Dyspnea on exertion gradually developed, and while the patient was in a Cincinnati hospital about this time, there was fever. Two months before she came to this hospital, the spleen was radiated, but no improvement resulted. This was followed by a diminution in the size of the spleen, but was also accompanied by a fall in the percentage of hemoglobin from 70 to 40. There had been a fairly progressive hemolytic anemia of eighteen months' duration. During the eighteen months of illness, her weight had fallen from 200 pounds (90.9 kg.) to 115 pounds (52.3 kg.). There had been no evident

loss of blood. The reports of the blood examination made Oct. 12, 1922, are as follows: red blood cells, 3,400,000; hemoglobin, 75 per cent.; color index, 1.0; white blood cells, 11,000; polymorphonuclears, 58 per cent.; polymorphonuclear eosinophils, 4 per cent.; lymphocytes, 32 per cent.; transitionals, 6 per cent. Jan. 16, 1923, the report was: red blood cells, 2,800,000; hemoglobin, 55 per cent.; color index, 1.0; white blood cells, 7,600. Feb. 15, 1923, the report was: red blood cells, 2,600,000; hemoglobin, 40 per cent.; color index, 0.8; white blood cells, 8,400.

When the patient was admitted to this hospital in August, 1923, the essential features of the physical examination were an enlarged spleen extending 5 or 6 cm. below the anterior iliac spine and 3 or 4 cm. to the left of the umbilicus, evident anemia and loss of weight, a displaced heart with an apical systolic murmur, an enlarged liver and leukoplakia. The Wassermann reaction was negative. There was slight decrease of the red blood cell osmotic resistance, probably within normal limits. Hemolysis began at .48 (normal control .44) and ended at .34 (normal control .34).

Later blood examinations were as follows: (on admission) red blood cells, 1,564,000; hemoglobin, 24 per cent.; color index, 0.8; white blood cells, 4,080; polymorphonuclears, 68.5 per cent.; polymorphonuclear eosinophils, 5 per cent.; polymorphonuclear basophils, none; lymphocytes, 25 per cent.; myelocytes, 1 per cent.; large mononuclears, 5 per cent. There was marked anisocytosis and poikilocytosis and no nucleated red blood cells were seen.

August 3, transfusion was done.

August 7, red blood cells, 2,303,000; hemoglobin, 34 per cent.; color index, 0.8; white blood cells, 3,720.

August 7, transfusion was done.

August 12, red blood cells, 2,350,000; hemoglobin, 35 per cent.; color index, 0.6; white blood cells, 7,840.

August 20, red blood cells, 2,352,000; hemoglobin, 41 per cent.; color index, 0.9; white blood cells, 4,000.

August 26, red blood cells, 2,464,000; hemoglobin, 40 per cent.; color index, 0.8; white blood cells, 4,160.

August 28, red blood cells, 2,328,000; hemoglobin, 45 per cent.; color index, 0.9; white blood cells, 5,160.

Splenectomy was refused by the patient. She was discharged September 6. February, 1924, the report was that the patient was living, but that she was very weak.

CASE 12.—B. W., a white man, aged 59, was admitted July 3, 1919. The patient's past history was negative for etiologic factors, with the exception of a gonorrheal infection at the age of 30, so that, although a syphilitic infection was denied, it could not be eliminated. He had always had "bad teeth." The onset of symptoms occurred June, 1917, about two years before his admission to this hospital, and was marked by the gradual development of dyspnea, dizziness and the occasional blurring of vision, which became progressively worse.

On examination made at the first admission, June, 1918, there was seen extreme oral sepsis, a slightly distended abdomen with dulness in the flanks. The spleen was firm and just below the costal margin. The liver was also palpable. A slight icteroid tint of the sclerae was seen. The blood examination reported: red blood cells, 2,860,000; hemoglobin, 60 per cent.; color index, 0.09; white blood cells, 3,600. The differential blood count was normal, as well as the red blood cell resistance. The Wassermann reaction was negative in two labora-

tories, and positive in a third. Stool and urine examinations were negative. The patient was discharged improved, after having received four injections of arsphenamin.

On returning to the hospital one year later, he stated that his health had remained good for three or four months, but that when he resumed an active life the abdominal swelling recurred. He had had four attacks of sharp epigastric pain, unaccompanied by jaundice. His general condition had become progressively worse, and the increasing shortness of breath and discomfort had again brought him to the hospital.

This examination revealed a slight icteroid tint to the skin, with melanoderma of the hands. There was no general glandular enlargement. The teeth were in a very bad condition. There was definite evidence of ascites, with enlarged liver and spleen, and considerable edema of the legs. The blood examination made on admission revealed: red blood cells, 2,800,000; hemoglobin, 75 per cent.; color index, 0.7; white blood cells, 3,400. On discharge, the report was: red blood cells, 3,400,000; hemoglobin, 67 per cent.; color index, 0.9; white blood cells, 4,800; polymorphonuclears, 52 per cent.; polymorphonuclear eosinophils, 6 per cent.; polymorphonuclear basophils, none; small lymphocytes, 30 per cent.; large mononuclears, 6 per cent.; unclassified, 6 per cent. (myeloid cells).

The blood picture was thought by Evans to be one which would fit any splenomegaly of long standing, not leukemic or actively infectious in origin. The anemia, the relative increase of lymphoid elements, the presence of unusual cell types and the absence of platelets is to be expected in cirrhosis of the spleen. Diagnosis was difficult between atypical pernicious anemia with liver cirrhosis, or atypical splenic anemia progressing rather rapidly. The gastric analysis revealed: free hydrochloric acid, 6 per cent.; combined acid, 27 per cent.; total acidity, 33 per cent. The Wassermann reaction was negative.

The patient was discharged July 24, and death followed an operation elsewhere in January, 1921.

Case 13.—E. W. S., a white man, aged 36, was admitted, Oct. 31, 1899. This patient gave a history of a primary syphilitic lesion, which was treated. Five years before admission to this hospital he had suffered from itching of the legs and diarrhea, while at the same time he had noticed his sallow color. A year later, the diarrhea recurred, and, four years later, a condition developed which was thought to be renal colic. He had only recently noticed the tumor in his left side. There was no ascites nor any history of hemorrhage, and the lymph glands were not generally enlarged. There was moderate secondary anemia, with leukopenia.

The blood examination revealed: red blood cells, 3,856,000; hemoglobin, 55 per cent.; color index, 0.7; white blood cells, 4,500. During his stay in the hospital, only general building up measures were used and the patient was discharged improved. The ultimate result, however, was death in 1904.

Case 14.—This case has been previously reported by Osler[8] and by Cushing and MacCallum.[14] It will be given in some details here as it is the most interesting in the series because of its typical symptoms, and because of the apparent benefit resulting from splenectomy. The blood picture after an unusually long period, twenty-five years, is noted.

C. D. B., a white man, aged 33, was admitted to the medical service March 9, 1898. He complained of hemorrhages, and pain in the left side. There was nothing in the history suggesting a familial disease. The first symptom, dyspepsia, was noticed thirteen years before. Indigestion with vomiting had

been pronounced for two years. There had been five hematemeses, the first five years before, the most recent five months before. He had had pain in the left side for four years, and had thought himself jaundiced at times.

The essential features of the examination were (1) dark complexion and bronzing of the skin; (2) systolic murmur at the cardiac apex, transmitted outward; (3) palpable spleen; (4) palpable glands. The gastric contents were normal. No roentgen-ray pictures were taken. Two blood examinations showed: (1) red blood cells, 3,072,000; hemoglobin, 35 per cent.; white blood cells, 2,800; (2) red blood cells, 3,150,000; hemoglobin, 47 per cent.; white blood cells, 3,100.

Dr. Osler, having in mind gastric ulcer, advised an exploratory laparotomy. The patient was discharged and returned November 6 for the operation. During the eight months, he had done very little work and had developed slight dyspnea. Examination at this time revealed a systolic murmur at the apex, transmitted to the anterior axillary line. The liver was 2 cm. below the costal

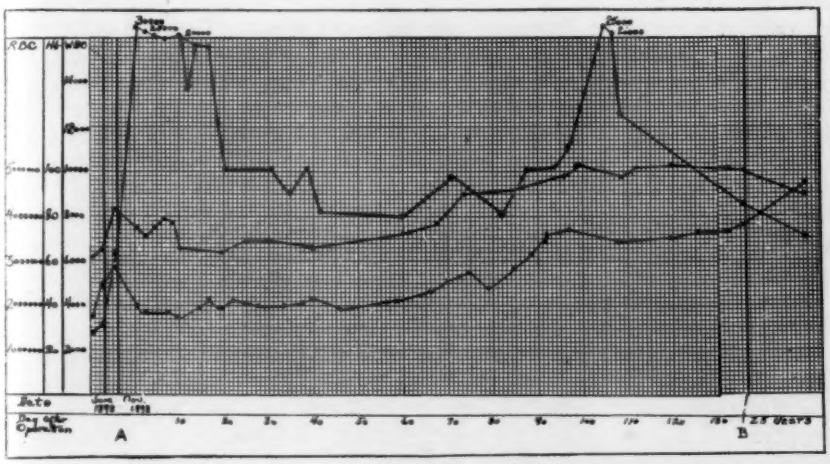

Fig. 1 (Case 14).—Blood observations: *A*, splenectomy, Nov. 8, 1898; *B*, observation, May, 1923.

margin in the mammary line, the spleen was enlarged, and there was localized tenderness in the left epigastrium. The blood examination showed some improvement in the anemia, the red blood cells numbering 4,020,000, the white blood cells, 6,428, and the hemoglobin was 57 per cent.

The operation was performed November 9, by Dr. Harvey Cushing, who was at that time the resident surgeon of the hospital. Since the examination of the stomach was negative, splenectomy was performed. The liver was smooth and showed no scarring.

Recovery after operation was uneventful. The postsplenectomy blood changes were closely followed by Dr. R. H. Follis and are shown in the chart (Fig. 1).

In May, 1923, he was asked to return to the hospital for examination. During the interval of twenty-five years, he has enjoyed good health and has been able to work fairly regularly, peddling and doing farm work. He has had two hematemeses, one in 1916, and the other in 1920. There has been occasional precordial pain. His appetite has been good, although there have been occa-

sional attacks of indigestion, sometimes accompanied by nausea and vomiting. He complains of hemorrhoids, probably due to the rather recently developing constipation. There have been no bone or joint symptoms. His average weight at present is 143 pounds (57.2 kg.). Examination showed a slight pallor of the mucous membranes. There was no jaundice but a brownish pigmentation; melanoderma was present, irregularly distributed over the body, mainly on the exposed parts alternating with patches of leukoderma. There was no general glandular enlargement. His teeth had been extracted. The tonsils were large and purplish in color. The heart was not enlarged. There was a faint, soft, transmitted systolic murmur at the apex. At the base over the aortic region was a systolic murmur rather louder than at the apex. The lower edge of liver dulness was at the costal margin and, on deep inspiration, the liver could be felt 3 or 4 cm. below the costal margin, in the mid-clavicular line. There were a few external hemorrhoids. The prostate was slightly enlarged.

May 23, 1923, the blood examination revealed: red blood cells, 4,592,000; hemoglobin, 75 per cent.; white blood cells, 6,360. May 24, the report was: red blood cells, 4,608,000; hemoglobin, 95 per cent.; white blood cells, 7,000. The differential blood count, May 23, was: polymorphonuclears, 67 per cent.; polymorphonuclear eosinophils, 6 per cent.; polymorphonuclear basophils, 7 per cent.; lymphocytes, 10 per cent.; large mononuclears and transitionals, 9.3 per cent. May 24, the report was: polymorphonuclears, 79 per cent.; polymorphonuclear eosinophils, 5 per cent.; polymorphonuclear basophils, 1 per cent.; lymphocytes, 7 per cent.; large mononuclears, 2 per cent.; transitionals, 6 per cent.

There was slight anisocytosis, but no poikilocytosis. No regeneration forms were seen. Platelets were increased. The percentage of hemoglobin was normal, as well as the number of red blood cells. The color index was 1+. The number of white blood cells was normal, with increased polymorphonuclear and polymorphonuclear eosinophil cells. The Wassermann reaction was negative, as well as the stool and urine examinations. Total urobilin excretion estimations were not made. A roentgen-ray picture of the chest showed that the lungs were clear and that there was a slightly dilated arch. There were no shadows along the vertebral column such as were found following a splenectomy in a case of hemolytic jaundice, which has not yet been reported. Sections of this tissue, taken at necropsy, which cast the shadows in the case mentioned, resembled bone marrow.

The total blood cholesterol was 340 mg. per hundred cubic centimeters of blood (148-180 mg. being normal), and the total fat was 2.10 mg. per hundred cubic centimeters (0.1-0.7 mg. being normal). The fragility of the red blood cells was markedly diminished, or expressed in another way, the resistance to hemolysis in hypotonic saline was markedly increased. Hemolysis began at 0.38, and ended at 0.18.

Briefly, this is a case of splenic anemia as described by Osler, which showed the usual symptoms including gastric hemorrhage over a period of nine years, indigestion and pain in the left side. There was a moderate grade of secondary anemia of the chlorotic type with leukopenia. The postsplenectomy blood changes were typical, showing a sharp increase in red blood cells for one week, after which there was an anemia which gradually rose to normal after ten weeks. The color index followed the number of red blood cells closely, remaining less than 1 for four months after operation, but now, after twenty-five years, it is greater than 1. There was an initial leukocytosis dropping to normal after one month, followed by a secondary unexplained leukocytosis three months after operation.

After twenty-five years, he was symptomless, and his blood was normal except for a color index over 1, and an increased proportion of polymorphonuclear neutrophils and eosinophils in an otherwise normal differential count. The red blood cell resistance was markedly increased, and there was three times the normal amount of cholesterol and total fats in the blood.

CASE 15.—H., a white man, aged 38, was admitted December, 1899. This case was also reported by Osler and Cushing. The onset occurred eleven years before admission. The patient had an attack of hematemesis without nausea, apparently esophageal in origin. For the last four or five years he had had tarry stools at intervals, but no hematemesis. Four years later he had the second attack, a massive hematemesis without nausea. The spleen was found enlarged at this time and has since remained in the same condition and of the same size. During the last four years he had two similar attacks of hematemesis and tarry stools.

The patient was fairly well nourished. The spleen was 10 cm. below the costal margin, and the liver dulness was much diminished. There were 4,018,000 red blood cells; the percentage of hemoglobin was 30-32; there were 6,500 white blood cells. The differential blood count was normal.

The examination made in January, 1900, showed a systolic bruit. The spleen extended 16 cm. below the costal margin, almost to the anterior spine. There was no edema of the legs. The blood examination revealed: red blood cells, 2,385,000; hemoglobin, 27 per cent.; color index, 0.57; white blood cells, 3,250. Splenectomy was performed January 8. There was a small amount of free fluid. The spleen was large, the surface rough and the capsule was calcified in places. The liver was slightly small with a rounded edge; its surface was slightly rough and coarsely granular, with fresh fibrous tissue, evidently early cirrhosis.

Death occurred January 8. At necropsy, the stomach contained 1,500 c.c. blood from a ruptured esophageal varix. There was thrombosis of the portal vein, a small esophageal ulcer, and possibly cirrhosis of the liver.

CASE 16.—F. G., a white man, aged 30, was admitted in April, 1901. There was a history of malaria eighteen years before admission. An enlarged spleen had been present for nine years, first noticed after an injury. Three years before, the patient had had his first hemorrhage from the stomach. Since he had had three hematemeses.

Examination revealed the fact that the spleen extended to within 2.5 cm. of the midline and 2.5 cm. from the umbilicus. There was no general glandular enlargement and no ascites. The liver was normal. The blood examination revealed: red blood cells, 3,344,000; hemoglobin, 28-30 per cent.; color index, 0.42; white blood cells, 4,200. After the second transfusion the red blood cells increased to 5,208,000 and the hemoglobin to 70 per cent.

Splenectomy was performed April 15, and death occurred three hours after the operation from hemorrhage.

The spleens removed in Cases 14, 15 and 16 were examined by Dr. W. G. MacCallum[14] and his description is quoted elsewhere in this paper.

CASE 17.—J. C. B., a white man, aged 22, was admitted in January, 1903. There was a history of chills and fever eight years before admission. An enlarged spleen had been present for seven years, extending a hand's breadth below the ribs. It had been hard and firm, and marked by a steady increase in size. Ten years before, the patient had vomited blood, and seven months ago there had been black stools.

Two blood examinations, June 11, 1908, revealed: (1) red blood cells, 3,320,000; hemoglobin, 40 per cent.; white blood cells, 4,500; (2) red blood cells, 4,436,000; hemoglobin, 60 per cent.; white blood cells, 7,500.

September 28, the abdomen was prominent in the upper left quadrant. There was a mass extending to the pelvis and to the right as far as the midline at a point 2 cm. above the level of the umbilicus. It descended 28 to 31 cm. below the costal margin. There was no edema. Two blood examinations revealed: (1) red blood cells, 4,256,000; hemoglobin, 80 per cent.; color index, 0.9; white blood cells, 2,520; (2) red blood cells, 3,724,000; hemoglobin, 70 per cent.; color index, 0.94; white blood cells, 800.

A splenectomy was done Oct. 1, 1903, and the patient made a good recovery.

Examination of the sections of the excised spleen showed that the capsule and trabeculae were thickened, and that there was a definite increase in the amount of connective tissue seen throughout the spleen. There was some extravasation of red blood cells, and the blood vessels were thickened, with hyaline changes. The malpighian bodies were atrophic. Endothelial proliferation was not noted.

Reports from the patient covering a period of two years showed a record of good health. He has not been heard from since.

Case 18.—J. E., a boy, white, aged 10, was admitted in May, 1908. The previous health of the patient had been good. He had had diarrhea in 1898, which had been diagnosed as amebic dysentery. His mother said that he had passed only small amounts of blood through the rectum. The patient stated that he had been aware of the abdominal tumor for one year. He complained only of the diarrhea. He has had no discomfort referable to the abdominal tumor.

Examination showed a large mass in the upper left quadrant. There were distended subcutaneous veins extending up over the lower thorax. There was demonstrable ascites. The blood examination revealed: red blood cells, 3,800,000; hemoglobin, 45 per cent.; color index, 0.60; white blood cells, 10,700. The differential blood count was normal: polymorphonuclears, 79 per cent.; polymorphonuclear eosinophils, 3 per cent.; small lymphocytes, 12 per cent.; large lymphocytes, 4 per cent.; polymorphonuclear basophils, 1 per cent.; large mononuclears and transitionals, 1 per cent.

Splenectomy was followed by recovery, and fourteen years after the patient was alive and well.

Examination of the sections of excised spleen showed that the splenic capsule was thickened, and that there were a few dense adhesions. The trabeculae were prominent, and there was a definite fibrosis of the whole organ. The red blood cell content of the organ was diminished, and the pulp was predominantly mature lymphoid in type. The malpighian bodies were slightly sclerotic. No endothelial proliferation was noted.

Case 19.—A boy, white, aged 9, was admitted in January, 1912. The patient had lived in Brazil until the age of 7 years. The onset of the present illness occurred with hemorrhage by mouth and by rectum, three years before, at the age 6. After that, he had twelve hemorrhages, including four hematemeses. The patient had amebic dysentery ten months before admission.

The child was pale but well nourished. There was a brownish tinge to his skin. The liver was not felt, and the spleen was much enlarged, extending beyond the umbilicus in the midline. The blood examination revealed: red blood cells, 3,170,000; hemoglobin, 50 per cent.; color index, 0.76; white blood

cells, 7,800; polymorphonuclears, 62 per cent.; polymorphonuclear eosinophils, 2 per cent.; small lymphocytes, 30 per cent.; large lymphocytes, 5 per cent.; large mononuclears and transitionals, 1 per cent.

Splenectomy was done, May 9, followed by good recovery, but after six months the child was reported dead. The etiology of the case is not known. Anemia was present before amebic dysentery, and there was a secondary anemia in a child with marked splenomegaly and ascites. The splenectomy was apparently without benefit.

Examination of the sections of excised spleen showed that the capsule and trabeculae of the spleen were thickened. The splenic pulp was predominantly mature lymphoid in character, with diminution in the usual number of red blood cells seen. The malpighian bodies were large and prominent. The blood vessels were slightly thickened. There were no normablasts seen, nor was there endothelial proliferation.

CASE 20.—H. E. B., a white man, aged 40, was admitted in August, 1912. The duration of the symptoms had been six months. The abdomen had been large for six months, and markedly so for one month. For three months the patient had easily become fatigued, and had had edema of the feet.

The patient was well nourished. There was general glandular enlargement. The abdomen was tense, particularly in the left upper quadrant. There was a mass extending 17 cm. below the costal margin. The liver was enlarged, dulness being increased to the fifth interspace on the right and 9 cm. below the right costal margin. There was shifting dulness in the flanks. The blood examination revealed: red blood cells, 4,000,000; hemoglobin, 70-75 per cent.; color index, 0.97; white blood cells, 3,500. The differential blood count was: polymorphonuclears, 49 per cent.; polymorphonuclear eosinophils, 2 per cent.; polymorphonuclear basophils, 1 per cent.; small lymphocytes, 36 per cent.; large mononuclears, 7 per cent.; transitionals, 1 per cent.; unclassified, 5 per cent.

Examination of the sections of excised spleen showed that the condition of the capsule and trabeculae were noted as that usually found in these spleens. There was fibrosis of the entire organ. The pulp was cellular, predominantly lymphoid, but immature lymphocytes were noted. The malpighian bodies were large and relatively scant. There was suggestive endothelial proliferation. The axillary lymph glands excised Aug. 31, 1921, for diagnosis, showed chronic lymphadenitis. Leukemia was not to be excluded.

Sept. 11, 1912, splenectomy was done, followed by good recovery. Death occurred in March, 1913.

The patient had suffered from secondary anemia with leukopenia with increase in small and large lymphocytes and unclassified forms at the expense of polymorphonuclears neutrophils. Possibly the disease was aleukemic lymphatic leukemia.

CASE 21.—D. B. S., a white man, aged 30, was admitted in June, 1913. The patient had malaria in July, 1911, two years before admission, the attack lasting three weeks. After the intermittent fever subsided the spleen remained enlarged. In September, 1912, nine months before admission the patient had convulsions, ushering in what appeared to be typical epileptic attacks recurring at intervals of about two months. For about one month he had had pain in the upper right quadrant. There was marked secondary anemia with leukopenia (chlorotic type).

There was fulness over left costal margin descending on inspiration. The mass was continuous with pelvic dulness. Two blood examinations revealed:

(1) red blood cells, 2,450,000; hemoglobin, 55 per cent.; color index, 1.10; white blood cells, 5,000; (2) red blood cells, 2,512,000; hemoglobin, 40 per cent.; color index, 0.8; white blood cells, 1,160. The differential blood count was: polymorphonuclears, 73 per cent.; polymorphonuclear eosinophils, 24 per cent.; polymorphonuclear basophils, 8 per cent.; small lymphocytes, 15.2 per cent.; large mononuclears, 6.4 per cent.; transitionals, 1.6 per cent. The Wassermann reaction was negative.

Splenectomy was done June 30, 1913, and the study of the postoperative blood changes was complicated by postoperative bronchopneumonia. August 1, there were 4,952,000 red blood cells, and the percentage of hemoglobin was 65. Recovery followed, and, after ten years, the patient was alive and well.

Examination of the sections of excised spleen showed that the capsule and trabeculae were thickened, and the usual fibrosis was noted. The pulp was lymphoid, with no increase in the amount of red blood cells noted. The malpighian bodies were large and few in number. There was no pigmentation. Pain for one month. Marked secondary anemia with leukopenia (chlorotic type).

Case 22.—C. L., a boy, white, aged 7, had had symptoms for the last two years. He had been languid and had had fever. There had been indefinite pains in the legs, loss of weight and a general enlargement of the abdomen, but no vomiting and no hemorrhages.

The patient was well developed and well nourished, but pale. There was bronzing of the skin, and a general glandular enlargement. The abdomen was enlarged. There was no fluid. The liver dulness extended to the sixth interspace and 6 cm. below right costal margin. The spleen was enlarged to the umbilicus and to the anterior superior spine. The blood examination revealed: red blood cells, 3,080,000; hemoglobin, 30 per cent.; color index, 0.48; white blood cells, 3,840. The differential blood count was: polymorphonuclears, 66 per cent.; polymorphonuclear eosinophils, 5 per cent.; polymorphonuclear basophils, none; small mononuclears, 15 per cent.; large mononuclears, 16 per cent.; transitionals, 3 per cent. There was poikilocytosis and anisocytosis, and a slight elevation of evening temperature. There was marked secondary anemia with mild leukopenia.

Splenectomy was done May 1, 1914, followed by a good recovery. The ultimate result was death, occurring eighteen months after the operation.

Case 23.—W. T., a white woman, aged 24, was admitted to Union Memorial Hospital, April 18, 1915. The past history of this patient included an appendectomy in 1906, nine years before admission to the hospital. She had had irregular, sometimes profuse, menstruation. For six weeks, she had easily become fatigued. Five months before coming to the hospital, she had had a sudden attack of hematemesis, unaccompanied by pain, which continued, at intervals, over two days. This occurred again four months later. Since this last attack, she had been weak and inclined to have shortness of breath. When she was examined there was definite pallor with a slightly greenish tinge to the skin, but no jaundice. Her teeth were uncared for. There was no general glandular enlargement. The spleen was enlarged four finger-breadths below the costal margin. It was firm and slightly tender. The urine examination was negative. No examination was made for urobilin. The Wassermann reaction was negative. The red blood cell resistance was not estimated. The blood examination revealed: red blood cells, 2,900,000; hemoglobin, 36 per cent.; color index, 0.6; white blood cells, 2,200; polymorphonuclears, 70 per cent.; small lymphocytes, 22 per cent.

Examination of a fresh blood smear showed some diffuse basophils, anisocytes, no nucleated red cells and no malarial parasites. She suffered from secondary anemia of the chlorotic type, with leukopenia.

Splenectomy was performed May 6, 1915, after which the patient made an uninterrupted recovery. A blood examination made five days after the operation showed: red blood cells, 2,944,000; hemoglobin, 40 per cent.; white blood cells, 9,200; polymorphonuclears, 72 per cent.; polymorphonuclear eosinophils, 1 per cent.; polymorphonuclear basophils, 1 per cent.; lymphocytes, 10 per cent.; large mononuclears, 16 per cent.

The patient was well in April, 1924, nine years after the operation. Her general health had been good. The blood count was as follows: red blood cells, 3,912,000; hemoglobin, 72 per cent.; color index, 0.9; white blood cells, 9,720. The differential blood count was: polymorphonuclears, 56 per cent.; polymorphonuclear eosinophils, 57 per cent.; large lymphocytes, 1 per cent.; small lymphocytes, 30 per cent.; large mononuclears, 2 per cent., and transitionals, 5 per cent. The red blood resistance was slightly increased, although it was within normal limits, the point of beginning hemolysis being .46 and the point of completion .26 (normal control. 48-.30). Estimation of blood cholesterol showed 260 mg. per hundred cubic centimeters (140-180 being normal), and the total of blood fats was 1.09 gm. per hundred cubic centimeters (.1-.7 gm. being normal).

CASE 24.—M. L. B., a white man, aged 30, was admitted Nov. 26, 1917. Two years before admission he had malaise, and noticed tarry stools. One and one half years before, he had his first hematemesis. The condition was diagnosed splenic anemia at that time. One month before admission he again had hematemesis and tarry stools. There was no jaundice or ascites. The spleen was enlarged, 10 cm. below costal margin. The liver was not enlarged. There was lymph gland enlargement. Blood examinations made November 26 and 27 revealed: (1) red blood cells, 3,360,000; hemoglobin, 74 per cent.; color index, 1.1; white blood cells, 2,500; (2) red blood cells, 4,344,000; hemoglobin, 72 per cent.; color index, 0.84; white blood cells, 2,500.

Splenectomy was performed December 18, at the Union Protestant Infirmary, Baltimore. The patient died of pneumonia following the operation.

CASE 25.—A. F., a boy, white, aged 16, was admitted April 28, 1916. The patient claimed to have always had an enlarged spleen, from which he suffered no discomfort. Two months previous to admission, following a dietary indiscretion, severe pain developed in the upper right quadrant, which radiated down the right side. The first night he vomited a considerable quantity of fresh blood. There was no nausea, and no blood in the stools. He had never been jaundiced. This pain was severe for four days, after which he remained in bed three weeks. He had no pain on admission, but came in for observation.

Examination revealed a slight glandular enlargement. The spleen was enlarged, extending in the midline 7 cm. below the iliac crest. The Wassermann reaction was negative. The blood examination revealed: red blood cells, 4,144,000; hemoglobin, 52 per cent.; color index, .6; white blood cells, 3,040; polymorphonuclears, 63 per cent.; polymorphonuclear eosinophils, 3 per cent.; polymorphonuclear basophils, 3 per cent.; small lymphocytes, 19.6 per cent.; large lymphocytes, 5.6 per cent.; large mononuclears, 3.2 per cent.; transitionals, 3.6 per cent.

Splenectomy was done May 3, 1914. Recovery was complicated by bronchopneumonia. The patient was given two transfusions after the operation, and was discharged after six weeks. The blood examination at discharge showed:

white blood cells, 14,440; hemoglobin, 55 per cent. The ultimate result of the operation is not known. The spleen weighed 1,410 gm. The capsule and trabeculae were thick, in some places markedly so. There were some areas of calcification and infarction. The pulp was moderately fibrotic and made up of decreased numbers of mature lymphocytes. There was evidence of some hyalinization of the thickened blood vessels. The malpighian bodies were prominent, and showed no sclerosis.

CASE 26.—L. G., a white woman, aged 28, was admitted in March, 1917. Except for alveolar abscesses the patient had had fairly good health up to her hospital admission. She dated the onset as occurring five years before admission in the fall of 1912, after the birth of her third child. At that time she had severe toothache, headache, nausea and vomiting; she had similar attacks during the next three months. In June, 1914, three years before admission, she had pain in the lower part of the abdomen, radiating upward, with nausea and vomiting. These attacks lasted two months, and during this time she was jaundiced. The jaundice cleared up with the disappearance of pain, but the weakness persisted. In the fall of 1914, her fourth child was born. While recovering from this labor, the patient had nausea and vomiting but no jaundice. In 1916, she suffered from shortness of breath, edema of the legs and swelling of the abdomen. In February, 1917, about one gallon of ascitic fluid was removed by tapping.

The patient was markedly pale and poorly nourished. There was no definite jaundice; the abdomen was full and round. There was a large mass beneath the left costal margin, ascending to the umbilicus. The liver was not definitely felt. The blood examination revealed: red blood cells, 3,940,000; hemoglobin, 60 per cent.; color index, 0.76; white blood cells, 6,800. The differential blood count was: polymorphonuclears, 74 per cent.; polymorphonuclear eosinophils, 2 per cent.; polymorphonuclear basophils, 2 per cent.; small mononuclears, 19 per cent.; large mononuclears, 4.8 per cent.

Splenectomy was done March 23, and infection developed in the operative wound. Thoracentesis was performed April 3, which yielded, on culture, a nonhemolytic streptococcus. Death occurred April 12. Necropsy revealed: anemia (operation); localized peritonitis with fat necrosis; general fibrous purulent peritonitis (operation); fibrous purulent pleurisy; bilateral multiple venous thrombi.

Examination of the sections of the excised spleen showed that the spleen was large and fibrotic but that there were no adhesions. The capsule was thickened and the trabeculae prominent. There was fibrotic change evident throughout the whole organ. The malpighian bodies were large and prominent, although they were relatively decreased in number. There was no increase in the red blood cells, in the splenic pulp, nor were nucleated forms seen. The pulp was predominantly lymphoid in character with a few endothelial cells to be seen.

CASE 27.—C. D. M., a white man, aged 22, was admitted Aug. 24, 1918. The patient's previous health had been good. The onset of the present illness had occurred suddenly three years before admission, with nausea and vomiting. A similar attack eighteen months later was accompanied by coffee ground vomitus. During the next twelve months, the patient had five hematemeses. He had tarry stools at intervals until January, 1918. A small hematemesis at that time prompted him to accept a surgeon's advice to be operated on. He stated that a gastric ulcer was suspected, but exploratory laparotomy revealed nothing but a scarring of the liver. In May, 1918, after his return to work, he had another attack of hematemesis and tarry stools.

The patient was well nourished but pale. There was no general glandular enlargement. The spleen was palpated three fingers-breadths below the costal margin. The liver could be felt one finger-breadth below the costal margin. There was moderate secondary anemia with leukopenia. The blood examination revealed: red blood vessels, 4,112,000; hemoglobin, 68 per cent.; color index, 0.82; white blood cells, 5,000. The differential count showed: a decrease in polymorphonuclears and an increase in small and large lymphocytes; polymorphonuclears, 53 per cent.; polymorphonuclear eosinophils, 2 per cent.; polymorphonuclear basophils, 2 per cent.; small mononuclears, 27 per cent.; large mononuclears, 17.8 per cent. There was moderate secondary anemia with leukopenia and polycythemia.

Splenectomy, performed August 26, was followed by an uneventful recovery. There was a postoperative afternoon rise of temperature, reaching its climax at 102 F. on the eleventh day, after which it returned to normal.

A report of a blood examination, furnished by the patient April 24, 1923, revealed: red blood cells, 6,330,000 (verified by several counts); hemoglobin, 90 per cent.; white blood cells, 11,000; polymorphonuclears, 59 per cent.; polymorphonuclear eosinophils, 1 per cent.; polymorphonuclear basophils, 2 per cent.; lymphocytes, 26 per cent; large mononuclears and transitionals, 12 per cent.

Examination of the sections of the excised spleen showed that the capsule and trabeculae were thickened. There was a proliferation of arteriolar intimae with a resultant narrowing of lumen. The malpighian bodies were large, and there was marked reduction of lymphocytes with proliferation of endothelium and general fibrosis throughout the organ. The red blood cell content of the organ was possibly reduced.

Five years after the operation, the patient was in good health. There were no gastric hemorrhages after the operation.

CASE 28.—G. H., a white man, aged 25, was admitted October, 1918. The onset of the patient's illness occurred ten years before his admission with hematemesis following abdominal trauma. Seven or eight years before there had been an attack of hematemesis followed at intervals by twelve others. One tarry stool was noticed after a severe period of nausea. For five years, after a doctor palpated his spleen, the patient had been aware that it had been enlarged. There had been no noticeable free fluid. After an attack of nausea and vomiting, the spleen seemed smaller. The blood examination revealed: red blood cells, 4,472,000; hemoglobin, 54 per cent.; color index, 0.60; white blood cells, 2,280. The differential blood count was normal. The Wassermann reaction was negative. There was secondary anemia with leukopenia.

Splenectomy was done October 10, and drainage was used. June 14, 1919, the patient was readmitted for another operation, the exploration of the old sinus tract. The drainage tract had closed one month after the operation and remained closed two months until an abscess ruptured spontaneously. The general condition was improved. There was no coughing. A letter, received after the patient's discharge, reported one hemorrage from the stomach, July 2. The patient died in October, 1922.

Examination of the sections of the excised spleen showed that the capsule was thickened in the usual manner. The trabeculae were prominent, and there was a reduction in the lymphoid and in the red blood cell content of the pulp, which was altered by the fibrosis uniformly evident. The malpighian bodies were large but small in number. There was no evident endothelial proliferation.

CASE 29.—F. M., a white man, aged 26, was admitted, Dec. 19, 1917. The first symptoms were noticed five years before admission, in 1913. The patient had three hematemeses during three years. He was operated on elsewhere and a gastro-enterostomy performed. The attacks of hematemeses had persisted. The blood examination, made on admission, revealed: red blood cells, 3,800,000; hemoglobin, 72 per cent.; color index, 0.92; white blood cells, 9,050.

Splenectomy was performed, Jan. 26, 1918. The patient made an uneventful recovery, and his condition was improved for one year. He died December 8, two days after an operation for the relief of acute intestinal obstruction.

Examination of the sections of the excised spleen showed that the capsule and trabeculae were thickened, and there was fibrosis seen throughout the whole organ. There was some increase in the red blood cells seen, but no nucleated red blood cells were to be found. The pulp was lymphoid in type. The malpighian bodies were large and prominent. The vessels did not appear to be particularly thickened, nor was there any endothelial proliferation evident.

CASE 30.—C. P. J., a white man, aged 34, was admitted in January, 1919. The onset of the patient's present illness had occurred one year before, in February, 1918. He had had several attacks of hematemesis, and there had been pain after eating, slight nausea, constipation and edema. One hematemesis occurred one month before admission.

The patient was only fairly well nourished. The spleen was readily palpable. The blood examination revealed: red blood cells, 3,744,000; hemoglobin, 42 per cent.; color index, 0.56; white blood cells, 2,400. After transfusion there were 3,496,000 red blood cells and the percentage of hemoglobin was 68. There was marked secondary anemia with leukopenia.

Splenectomy was done Jan. 23, 1919. The spleen was markedly enlarged and covered with fibrous, tough adhesions. The liver was cirrhotic. The patient made an uneventful recovery.

In June, 1923, Dr. Thomas L. Harris, of Parkersburg, W. Va., wrote that the patient was living and able to work as a salesman. Since his discharge from hospital, he had had three severe gastric hemorrhages which, in two instances, required transfusions. The first hemorrhage occurred during the winter of 1919. There was at that time an extreme ascites which required two paracenteses. At first, three gallons (7.58 liters) of fluid was obtained and at the second, a week later, two gallons (7.58 liters). There were hemorhages in 1921, and in 1923, but no recurrence of the ascites.

Examination of the sections of the excised spleen showed that the spleen, while enlarged and adherent, did not have the markedly thickened capsule usually seen. The trabeculae were broad and branching. The microscopic appearance, with the exception of the uniform moderate fibrotic change throughout the organ, was not very abnormal.

CASE 31.—W. R. D., a white man, aged 34, was admitted, November 13, 1919. The first symptoms were noticed four years before, in 1915. There was an attack of diarrhea lasting two weeks, during which there was an attack of hematemesis producing a half pint of blood. During 1916 and 1917, the patient noticed bloody stools, and had twelve hematemeses of about a half pint each. One hematemesis occurred in 1918-1919. The large spleen was noticed in 1919. The patient, on admission, complained of shortness of breath and abdominal discomfort. He had had six injections of arsphenamin during 1916-1918, and five blood transfusions in 1917.

The patient was undernourished, sallow and pale. There was marked secondary anemia with leukopenia, chlorotic type. The heart was displaced upward. The spleen was almost to the umbilicus with bosses on its surface. There was slight ascites. The liver dulness was normal, and the Wassermann examination was negative. The patient suffered from weakness, vertigo and dyspnea. The blood examination (November 7) revealed: red blood cells, 3,024,000; hemoglobin, 35 per cent.; color index, 0.76; white blood cells, 3,400. November 13, the report was: red blood cells, 5,352,000; hemoglobin, 82 per cent.; white blood cells, 2,880. The differential blood count was: polymorphonuclears, 68 per cent.; polymorphonuclear basophils, none; polymorphonuclear eosinophils, 0; small mononuclears, 24 per cent.; large mononuclears, 8 per cent.

Splenectomy, performed Nov. 15, 1919, resulted in a good recovery. The blood examination is shown in Figure 4. The patient was living and enjoying good health four years after the operation, although he had since had two gastric hemorrhages.

Examination of the sections of excised spleen showed that the spleen was large and firm. There were no adhesions, and the capsule and trabeculae were as usual. The spleen corresponded with the typical description as to the fibrosis, etc. There were occasional nucleated red cells seen.

CASE 32.—E. S., a girl, white, aged 7½ years, was admitted Jan. 20, 1920. The patient's past history was quite uneventful. Her infancy was normal except for dietary upsets. She had bronchopneumonia in November, 1913, and tonsillitis and purulent rhinitis in January, 1914. In July, 1914, a double mastoid operation was performed. In August, 1914, abdominal tenderness called attention to the enlarged spleen. This had been present without tenderness during the six years preceding her admission to the hospital. Tonsillectomy was performed in November, 1914. In December, 1916, the first gastric hemorrhage occurred; the amount of blood lost being estimated at about 700 or 800 c.c., after which the hemoglobin was 70 per cent. In January, 1917, the patient had an attack of acute endocarditis from which she did not recover until June, 1917. There were two other gastric hemorrhages, one in October, 1918, and the other in December, 1919. The spleen was said to be smaller after a hemorrhage or after purgation.

On examination, it was noted that she was undernourished, was not jaundiced and had no general glandular enlargement. There was a loud systolic murmur heard over the precordium, loudest over the base. The superficial veins of the abdomen were more pronounced than normal. The liver was not enlarged, but the spleen extended 11 cm. below the costal margin in the mammary line. It was firm and smooth. The blood examination revealed: red blood cells, 3,728,000; hemoglobin, 70 per cent.; color index, 0.9; white blood cells, 4,500. The differential count was: polymorphonuclears, 48 per cent.; polymorphonuclear eosinphils, 1 per cent.; small lymphocytes, 42 per cent.; large mononuclears, 3 per cent. The osmotic resistance of the red blood cells was normal in one examination and decreased in a second. The Wassermann, Pirquet and tuberculin tests were negative. The roentgen-ray examination of the chest showed infiltration of the bases, which suggested a non-tubercular infection, and large mediastinal glands, which suggested tuberculosis. The urine was normal, although the examination for urobilin was not noted.

Splenectomy was performed, Jan. 24, 1920, and was followed by a good recovery. In May, 1920, during a febrile attack, *Streptococcus viridans* was found in the blood culture. In June, 1922, the patient had a gastric hemorrhage, but has been well since.

Examination of the sections of the excised spleen showed that the spleen was very firm, and the malpighian bodies prominent. The capsule was slightly thickened. The malpighian bodies were normal in size, but apparently diminished in number. The blood sinuses were not engorged. There were no areas of hemorrhage or infarcts. There was a decrease in the lymphocellular content of the pulp and a definite increase in the connective tissue reticulum, amounting to a fine fibrosis. The blood vessels showed definite thickening of the walls.

Case 33.—M. M., a white woman, aged 43, was operated on for splenectomy, Nov. 4, 1921. The onset of the poor health of the patient had occurred five years previous to her admission to the hospital. In general, her past health had been good and the family history was negative. In 1916, the patient noticed difficulty in swallowing. There had been definite symptoms for two years, since 1919, when the patient developed anemia. She had extreme pallor for three years, weakness on exertion, and shortness of breath, palpitation of the heart and edema of the legs for two years. There had been no vomiting of blood.

The patient's skin was yellow. There was no general glandular enlargement. The liver edge was palpable 5 cm. below the costal margin. It was hard and smooth. There was no ascites, but edema of the extremities was noted. A roentgen-ray examination showed general fibrosis of both lungs. The Wassermann reaction was negative. The blood examination made October 19, revealed: red blood cells, 2,000,000; hemoglobin, 30 per cent.; color index, 0.78; white blood cells, 2,000. The differential blood count showed: many reticulated red blood cells; platelets, 152,000; polymorphonuclears, 79 per cent.; polymorphonuclear eosinophils, 0; polymorphonuclear basophils, 0; small lymphocytes, 11 per cent.; large mononuclears, 1 per cent.; transitionals, 6 per cent.; the red blood cell fragility was slightly decreased (resistance increased). Hemolysis began at 0.44, and was complete at 0.28.

After the splenectomy, November 4, the patient made a good postoperative recovery, which was marked by an increase of red cells to over 4,000,000 and of hemoglobin to 50 per cent. There was a sharp postoperative leukocytosis. The results of the blood examinations are shown in Figures 3 and 3*a*. November 24, three weeks after splenectomy, the red blood cell osmotic resistance was practically the same, 0.40-0.26. The platelets had increased to 1,396,000.

Examination of the sections of the excised spleen showed that the spleen was dark red and rubbery. The pulp did not scrape away easily. Microscopically, there was diminution of blood and increase of eosin staining and hyaline material. The pulp was essentially lymphoid, although this element was largely replaced by proliferated connective tissue.

Later admission to hospital took place from Jan. 25 to Feb. 3, 1923. The patient had gained 26 pounds (10.4 kg.) since splenectomy, weighing between 130 (52 kg.) and 156 (62.4 kg.) pounds. She was well nourished and her color was good. The abdomen was normal, except for the scar, and the liver was palpable. The patient had a beefy red tongue with papillary atrophy. There was a slightly yellowish tinge to the skin. To some observers, it suggested an atypical pernicious anemia. The vibratory senses were unimpaired, and the deep reflexes were active.

The blood examination revealed: red blood cells, 3,636,000; hemoglobin, 60 per cent.; color index, 0.7; white blood cells, 4,720. After transfusion the report was: red blood cells, 4,016,000; hemoglobin, 48 per cent.; color index, 0.5; white blood cells, 6,760. The differential blood count was: polymorphonuclears,

29.5-32 per cent.; polymorphonuclear eosinophils, 3-1 per cent.; polymorphonuclear basophils, 1-1.5 per cent.; lymphocytes, 44-45.5 per cent.; large mononuclears and transitionals, 22-20 per cent.; unclassified, 1 per cent. There was a marked anisocytosis and poikilocytosis. The red cells, hemoglobin and white cells were reduced. There was a proportionate increase in large mononuclears and transitional cells. There was a marked grade of secondary anemia with leukopenia. This case was interesting because it presented features common to both splenic anemia and pernicious anemia. Splenectomy had some beneficial effect on the anemia, and had a noticeable effect on the differential formula, bringing about a marked decrease of polymorphonuclears and an increase of large mononuclears and lymphocytes. The color index was always low. When the patient was heard from in February, 1924, she stated that her physician said she was still anemic.

Case 34.—I. D., a white woman, aged 42, was admitted in January, 1923. The patient had had enlargement of the abdomen dating from 1916. She complained of weakness. There was greyish pigmentation of the hands and wrists. Hemorrhoidectomy was performed in 1916 and 1918. The blood examination, on admission, revealed: red blood cells, 3,776,000; hemoglobin, 35 per cent.; color index, 0.46; white blood cells, 1,760. The differential count showed: polymorphonuclears, 60 per cent.; lymphocytes, 30 per cent. The urine contained urobilin. After two transfusions, the blood count revealed: red blood cells, 5,024,000; hemoglobin, 80 per cent.; white blood cells, 2,980.

Splenectomy was performed January 12. On examination in February, 1924, the patient was apparently in good health. The blood examination revealed: red blood cells, 4,680,000; white blood cells, 9,160; hemoglobin, 50 per cent.; color index, 0.55. The differential blood count showed: polymorphonuclears, 47.5 per cent.; polymorphonuclear eosinophils, 1.5 per cent.; polymorphonuclear basophils, 1 per cent.; small lymphocytes, 31 per cent.; large lymphocytes, 3 per cent.; large mononuclears, 5 per cent., and transitionals, 11 per cent. There was marked anisocytosis, moderate poikilocytosis and normal platelets. There was no increased diffuse or punctate basophils and no nucleated red blood cells were seen. When the osmotic resistance of the red blood cells was examined after one year, the point of beginning hemolysis was practically identical with the normal control, 0.52. The point of complete hemolysis was considerably reduced, 0.22, as compared with 0.34, the normal control.

Case 35.—A white man, aged 36, was admitted July 25, 1923. The patient complained of aches and pains, bad taste and fatigue. The past history included oral sepsis, chronic tonsillitis, nasopharyngitis, and the moderate use of alcohol. For one year he had noticed a bad taste in his mouth, and had been troubled with momentary mental confusion for from eight to ten months. There had been numbness of the upper extremities for six or eight weeks and transitory pains of the lower extremities. His appetite had been good, and he had noticed pallor for one year.

The patient was afebrile except following transfusions, his Wassermann reaction was negative and an examination of the gastric contents showed no free hydrochloric acid; total acidity was 12 per cent. A blood examination, made one month before admission, revealed: red blood cells, 1,672,000; hemoglobin, 24 per cent.; color index, 0.75, and white blood cells, 12,080. There was anisocytosis, poikilocytosis and polychromasia, and the differential count showed: polymorphonuclear neutrophils, 82 per cent.; polymorphonuclear eosinophils, 1 per cent.; small lymphocytes, 8 per cent. The blood picture was not noticeably helped by transfusion. The patient was well nourished, of a sallow yellow

and showed a lingual atrophy. The liver was 2 cm. below the costal margin, and the spleen 4 cm. His examination in the hospital after treatment, including transfusion, etc., revealed: red blood cells, 1,824,000; hemoglobin, 50 per cent.; white blood cells, 10,000. There was 40 per cent. free hydrochloric acid and the combined acidity was 13 per cent., with a total of 61 per cent. The urine showed bile and urobilin. The Wassermann reaction and the blood cultures were negative. There was decreased red blood cell resistance, hemolysis beginning at 0.58 per cent. (normal control 0.44 per cent.) and ended at .38 per cent. (normal control .32 per cent.). Splenectomy was performed July 28, and the patient died four days after the operation.

Examination of the sections of the excised spleens showed that the spleen was not particularly firm, was more reddish brown than purple and showed several infarcts. The vessels, as palpated at operation, were not thrombosed. There was considerable blood in the organ. Sections showed fairly marked fibrosis. The pulp was lymphoid, and showed several nucleated red cells. The malpighian bodies were large and there was no apparent arteriolar intimal proliferation.

Examination of the sections of the excised spleen showed that the spleen was not particularly firm, was more reddish brown than purple and showed several infarcts. The vessels, as palpated at operation, were not thrombosed. There was considerable blood in the organ. Sections showed fairly marked fibrosis. The pulp was lymphoid, and showed several nucleated red cells. The malpighian bodies were large and there was no apparent arteriolar intimal proliferation.

ETIOLOGY

Although Osler[16] and many following him[17] have required an unknown etiology for the diagnosis of splenic anemia, the fact remains that we have many diseases with suggestive etiology which exactly reproduce this syndrome. This must again raise the question whether or not a single etiologic cause underlies the condition. In any consideration of the general question of anemia, aside from the visibly hemorrhagic form, one is confronted with the absence of any proved and accepted explanation of the mechanism of blood balance in the body. We accept the fact that there is continuous activity of a widely distributed hematopoietic tissue, which in health is exactly balanced by a hematocatatonistic function. The amount of this destruction and replacement has been shown by Eppinger and Charnas[18] to be one thirty-fourth of the total blood in twenty-four hours. It is obvious that

16. Osler (Footnotes 5 and 8); Discussion of Splenic Enlargements Other Than Leukaemia, Brit. M. J. **2**:1151, 1908.

17. Moynihan (Footnote 3). Barker, L. F.: Special Diagnosis of the Principal Diseases of the Blood and Hematopoietic Organs. Clinical Diagnosis of Internal Diseases, New York, D. Appleton & Co., **2**:180-260, 1916. Cushing and MacCallum (Footnote 14). Pearce, Krumbhaar and Frazier (Footnote 10). Pool, E., and Stillman: The Surgery of the Spleen, New York, D. Appleton & Co., 1923.

18. Eppinger, H., and Charnas, D.: Was lehren uns quantitative Urobilinbestimmungen im Stuhl? Ztschr. f. klin. Med., Berlin **78**:387, 1913.

an uncompensated disturbance in either of these balanced factors (other factors being equal, such as iron availability, etc.) will produce the clinical manifestations recognized as anemia or polycythemia. The usual bodily mechanism, a balance of forces, also applies here. Either factor of this balance may compensate, to some extent, a disturbance of the normal functioning of the other. It is the break or weakening of this compensation which brings about the recognized manifestations of disease.

While we accept the bone marrow as being the seat of greatest blood formation, little is actually known of the mechanism of blood destruction. The difficulty may possibly lie in the multiplicity of ways in which it may be accomplished, such as phagocytosis, fragmentation and hemolysis,[19] while a further difficulty presents itself in the attempt to attribute this function to one or all of several organs, the spleen, liver, and bone marrow. The conception of a reticulo-endothelial cell apparatus attempts to provide an organ or system for this function.[20] Clinical examinations have aided but little in advancing our knowledge. Examination of the blood smear indicates the degree of ability of the erythropoietic apparatus to function, and the resistance of the erythrocytes to hemolytic agents suggests the possible duration of life in the body. The presence of more or less splenomegaly points to some involvement of the spleen, and early led to the use of splenectomy on purely empirical grounds.

Until we are able to establish an etiologic classification of the various forms of anemia, any classification must rest on rather untrustworthy clinical evidence. Pathologic evidence has so far proved equally unreliable. The classification must go much farther than "aplastic or hemolytic." It must explain at what point in the balance the break occurs. Clinically, we recognize three groups which are thought to be due to the blood destruction: pernicious anemia, hemolytic jaundice and so-called splenic anemia, of which Banti's disease and von Jaksch's anemia are representatives, and the tendency is to subdivide much more on the basis of clinical symptoms. The condition without decreased resistance, but with serum hemolysins, described by Chauffard and Troisier as "ictere hemolysinique," and that condition described by Banti [21] as an exhaustion of the bone marrow with leukopenia and

19. Peabody, F. W., and Brown, G. O.: Phagocytosis of Erythrocytes in Pernicious Anemia. Preliminary Note, J. A. M. A. **82**:963 (March 22) 1924. Rous, P.: Destruction of the Red Blood Corpuscles in Health and Disease, Physiol. Rev. **3**:75, 1923.

20. Eppinger, H., and Ranzi, E.: Die Hepato-Lienalen Erkrankungen und die Operationen an der Milz bei den Hepato-Lienalen Erkrankungen, Berlin, 1920.

21. Banti, G.: Splénomégalie hémolytique anhémopoietique, le rôle de la rate dans l'hémolyse, Semaine Méd. **33**:313, 1913.

designated splénomégalie hémolytique anhémopoietic as contrasted with splénomégalie hémolytique, the spodogenous form, are examples. If this trend will further our knowledge of etiology and assist us in deciding treatment, it should be encouraged. Until we are able to decide on more definite grounds, we must rely on clinical findings for the knowledge that will indicate or contraindicate the removal of the spleen. It is possible to arrive at sound conclusions from the study of late results in the three groups of anemias in which splenectomy was performed. For comparison, it is essential that many cases not operated on be studied, in order that we may learn the natural history of the disease. There is a natural tendency for surgeons to study only the results in their splenectomized cases.

With our present knowledge, we may accept the fact that an anemia may be truly idiopathic, a malfunction of a normal and necessary bodily process. But, on the other hand, there are constantly encountered cases in which an etiologic factor is strongly suggested. There is every reason to believe that an anemia may be brought about by the action of a variety of agents acting either on the hemolytopoietic system or on the blood itself. The anemia may be an immediate result or a late manifestation of the effect of some infection on any part of this system regulating the normal composition of the blood.

Among the conditions which, for years, have been found in connection with anemia of increased blood destruction accompanied by splenomegaly are syphilis, malaria and tuberculosis. The frequent marked splenomegaly has pointed to the spleen as being the cause or at least the site of the pathologic process, and it is known that these diseases may be responsible for splenic alteration, which exactly simulates the syndrome with unknown etiology. The search for a single causative agent has led to the discarding of these diseases as etiologic factors. Marchand called attention to the relation of syphilis and tuberculosis in this syndrome, accompanied by a fibrotic spleen. Tileston [22] found that syphilis in the secondary stage of the florid type is associated with the syndrome of hemolytic jaundice. Furno [23] found syphilis of the spleen, or syphilis, as a basis of the splenohemolytic syndrome in many cases. He associated it in the secondary stage with the more typical picture of hemolytic jaundice, and in the tertiary stage with a much greater variety of manifestations, including the typical Banti's disease. He finds that, in the congenital type, it may sooner or later show typical Banti's disease or typical hemolytic jaundice.

22. Tileston, W.: Hemolytic Jaundice, Medicine **1**:355-388 (Aug.) 1922.

23. Furno, A.: Sulla sifilide della Milza, Policlinico (Med. Sec.), Rome **29**: 123 (March) 1922. (Quoted by Rolleston, Footnote 24.)

De Stephano [24] claims a syphilitic origin for most splenic anemias in children, and that, aside from direct transmission, it may result in an inherited dystrophy in which any factor may act as the occasional cause. Barker [25] states that chronic enlargement of the spleen may be due to gumma or to diffuse syphilitic splenitis, and that splenomegaly may be very common in congenital syphilis. Rieux [26] was much impressed with the close relationship of hereditary syphilis to Banti's disease. Eason,[27] in considering anemia with chronic splenomegaly in syphilitics, states that this chronic condition in its developed state occurs in the tertiary form of acquired syphilis, and that throughout the entire tertiary period the sole clinical difference from Banti's disease may be the history or demonstration of syphilis and abdominal pain and tenderness. The latter, however, may not always be present. Pool [28] found the spleen frequently involved in all stages of syphilis except the primary. The lesion, except in the congenital form, is rarely gummatous but is usually a diffuse interstitial splenitis similar to that found in cirrhosis of the liver and in splenic anemia (Banti's disease). He states that, in hereditary syphilis, the spleen may be enormous, and that the associated symptoms present the picture of splenic or von Jaksch's anemia. In connection with arsenic therapeusis, Hill,[29] on the basis of studies in red cell resistance, claimed that the beneficial effect of arsenic in the anemias was due rather to a prevention of hemolysis, than to a stimulant effect on the bone marrow. This was not substantiated by Robertson,[30] who based his opinion on studies of urobilin excretion after arsphenamin.

The spleen may be greatly enlarged in chronic malaria, but there is rarely jaundice except in the acute attacks. The form that Bates [15] describes, the Colombian spleen, in which plasmodia and pigmentation are absent, may be much commoner than is generally supposed. A malarial history may be elicited, but the picture is that of splenic anemia, as it was in several of the cases coming to my attention.

Tuberculosis of the spleen is rare,[25] but may cause great enlargement, sometimes occurring without the evidence of tuberculosis of other

24. De Stephano, cited by Rolleston, J. D.: Diseases of the Spleen, Medical Science Abst. and Rev. **7**:202, 1922.

25. Barker (Footnote 17, second reference).

26. Rieux, J.: Actual State of the Problem of Banti's Disease, Médecine, Paris **4**:458 (March) 1923; Abstr. J. A. M. A. **80**:1815 (June 16) 1923.

27. Eason, J.: The Anemias of Syphilis, Brit. M. J. **2**:186 (Aug. 6) 1921.

28. Pool and Stillman (Footnote 17, fifth reference).

29. Hill, L. W.: The Resistance of the Red Blood Cells to Hypotonic Salt Solution in the Various Anemias, Arch. Int. Med. **16**:809 (Nov.) 1915.

30. Robertson, O.: Urobilin in the Stool in Pernicious Anemia as Influenced by Splenectomy, Transfusion and Salvarsan, Arch. Int. Med. **16**:435 (Sept) 1915.

organs. Winternitz [31] made exhaustive studies of splenic tuberculosis and described it as occurring in a primary and a secondary form. The latter, according to Haman's figures, which he quotes, is not uncommon. It was found in 66.7 per cent. of 428 cases in children under 10 years, and in 19.1 per cent. of 836 cases in adults between the ages of 15 and 90. In 1899, Rendu and Widal described the symptom complex of splenic tuberculosis, and noted polycythemia without leukemia. Winternitz examined the blood of twenty-six patients and found it normal in nine, anemic in eleven and polycythemic in six. Bufalini distinguishes three different forms of tuberculous splenomegaly, the caseous tuberculous, miliary tuberculosis and tuberculous necrosis.

Rickets [6] is often an etiologic factor in splenic anemia, particularly in cases of von Jaksch's anemia in children. This form of splenic anemia is thought to be the result produced by the characteristic response of the infantile hematopoietic system. Evans and Happ [32] found that any chronic infectious process in children often led to splenomegaly with anemia.

Many organisms have been described as being the etiologic agent of this condition. These have been based, for the most part, on cultures from diseased spleens. Several have produced similar lesions when they were injected into animals. Although Rolleston believes that the infectious nature of the condition is responsible for the splenomegaly, he feels that the large spleen mechanically causes the gastric hemorrhages that are responsible for the anemia. It was pointed out by Hollins,[33] however, that in many cases there is a marked anemia in which there is no history of gastric hemorrhage, and that this anemia must be due to some toxic factor. In our cases, it has been seen that the presence or even the grade of anemia is not dependent on gastric hemorrhages, but that it is related to an actual blood destruction. Hollins demonstrated by animal inoculation that the *B. coli-communis* was at least one causal micro-organism of splenic anemia, and he thought that it was the only one. Yates, Bunting and Kristjanson [34] were much impressed with the finding of a diphtheroid bacillus in some of their cases. This finding, together with their interpretation of the pathologic changes of the excised spleens, led them, in a preliminary report, to conclude that splenic anemia or Banti's disease was closely related to, if not a variation in manifestation, of a single type of infection. Gibson,[35]

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31. Winternitz, M. C.: Tuberculosis of the Spleen, Arch. Int. Med. **9**:680 (June) 1912.

32. Evans and Happ (Footnote 6, second reference).

33. Hollins, T. J.: Primary Splenomegaly or Splenic Anemia Studied with Special Reference to the Pathogenesis, Practitioner, London **44**:426, 1915.

34. Yates, J. L.; Bunting, C. H., and Kristjanson, H. T.: The Etiology of Splenic Anemia or Banti's Disease. Preliminary Note, J. A. M. A. **63**:2225 (Dec. 19) 1914.

35. Gibson, A. G.: On the Infective Nature of Certain Cases of Splenomegaly and Banti's Disease, Quart. J. Med., Oxford **7**:153, 1914.

in 1914, described a streptothrix as an etiologic agent, and in 1924,[36] in a series of ten monkeys he was able to reproduce splenomegaly with anemia and felt that Koch's postulates had been complied with.

Other organisms which have been described in connection with hemolytic anemia are those of paratyphoid and dysentery. Streptococci and *B. aerogenes-capsulatus* have been noted.[22] The cultures of the last, according to Widal, are rarely hemolytic in vitro. "Acute intoxication" from intestinal stasis is emphasized by W. J. Mayo in discussing the possible relation of the large intestine to pernicious anemia. Many of the tropical forms of splenomegaly are quite indistinguishable from exogenous splenic anemia. In some, such as Kala Azar, the parasitic origin may be demonstrated and others may be distinguished only by the presence of a characteristic fever. In some of these, cirrhosis of the liver marks the end stages of the process.

The most probable view, supported by Banti,[37] is that it is a chronic infectious process with its chief seat in the spleen, and that the poisons cause the connective tissue and endothelial proliferation, the anemia and ultimately the cirrhosis of the liver. Osler,[38] in a later (1908) discussion of the condition, states that we have come to recognize the fact that nearly all of the diseases of the spleen are secondary in nature, and that there is no question of the symptoms being due to any splenic inadequacy, since we know that the organ is not necessary for life.

THE PATHOLOGY OF THE SPLEEN

The microscopic appearance of the spleen in this condition has been exhaustively studied, but has apparently yielded very little information as to the underlying process. It leads us by another route to the same point, beyond which we have been unable to pass. Until we are able to interpret normal splenic function in terms of normal splenic anatomy we will be unable to appreciate the meaning of the changed microscopic appearance in disease. The splenic pathology has been described by nearly all observers whose names are identified with splenic disorders. Recent work has contributed little more than was previously known. Banti,[9] who was the first to call attention to the sequences leading to cirrhosis of the liver and ascites, recognized the fibrous change in the splenic pulp and the sclerosis of the malpighian bodies in the enlarged spleen. He aroused considerable interest in this condition, and many contributions were made beginning about 1900.

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36. Gibson, A. G.: Experiments on the Etiology of Chronic Infections of the Spleen, Quart. J. Med., Oxford **17**:191 (Jan.) 1924.

37. Banti, G.: The Clinical Aspects of Hemolysis, Tr. Internat. Cong. Med. **6**:1, 1913.

38. Osler (Footnote 6, third reference).

For the most part, with only minor variations, these descriptions have coincided with Banti's. Harris and Herzog,[39] in this country, called attention to the finding of large endothelial cells with clear protoplasm containing two nuclei, and among them giant cells, but it is possible that these changes may have occurred in an unrecognized Hodgkin's disease of the spleen, or, as I have seen, in the spleen of myelogenous leukemia. Bovaird[40] also described the endothelial hyperplasia, and rather favored the idea of a transformation of these large endothelial cells into fibrous tissue. There was some confusion at that time with Gaucher's disease, which was at first thought to be a form of splenic anemia. Jawein[41] was one of the earliest experimenters and showed that, by injecting erythrolytic substances, enlargement of the spleen may be produced.

Osler[5] established, at about that time, a very definite clinical picture of the condition, but stated "we do not know whether the anemia is secondary to the enlarged spleen or whether as seems more probable both are secondary to some cause as yet unknown. Until we have further knowledge it is useful to group together cases of splenomegaly with anemia and without lymph gland enlargement and call the condition splenic anemia". The pathologic changes of three of Osler's cases were described by MacCallum,[14] whose account was not published until 1920, when it appeared with a clinical lecture by Cushing, in which was reviewed the "Bowman Case" (Case 14 of this paper). MacCallum describes the microscopic anatomy in minute detail and, in condensing his findings, states that the malpighian bodies show practically no pathologic changes of any significance, and that in the pulp there is apparently a great increase in the number of the venules, which are not dilated, but which from the loss of cellular tissue between them, have come to compose the greater part of the tissue. The basketwork of fibrils surrounding these venules seems not to be much altered, but there is a definite new growth of connective tissue between the venules. The endophlebitis described by Banti did not impress him. He found no evidence of great hemolysis in the spleen or elsewhere in the body, except the regenerative activity of the bone marrow. MacCallum, in considering these changes, even when they were taken together with the other details which Banti brought for-

39. Harris, W., and Herzog, W.: Splenectomy in Splenic Anemia, Ann. Surg. **34**:119, 1901.

40. Bovaird, D., Jr.: Primary Splenomegaly, Endothelial Hyperplasia of the Spleen, Am. J. M. Sc. **120**:377 (Oct.) 1900.

41. Jawein: Ueber die Ursache des acuten Milztumors bei Veriftungen und acuten Infectionskrankheiten, Physiologische Function der Milz, Virchows Arch. f. path. Anat. **161**:461, 1900.

ward, did not feel that they were sufficiently characteristic from the anatomic point of view to justify the classification of the condition as a separate disease; he felt that a classification must rest until an etiologic factor is determined largely on the clinical course of the disease. He felt that speculation as to the nature of the process would probably lead to no definite result, but that it did not seem unreasonable to suppose that some toxin, perhaps with a mild hemolytic action, might act primarily to produce an enlargement of the spleen and, later, a cirrhosis of the liver.

Warthin and Dock in 1904, confirmed Banti's observation on the changes in the veins of the portal system which, however, had not impressed MacCallum in his cases, and in 1910 Warthin [42] was very enthusiastic over the idea of portal and splenic phlebosclerosis. Warthin recounted the observations of many observers, beginning with Morgagni, who had described this condition and raised the question as to whether or not these splenic changes could be brought about by marked and long continued chronic passive congestion. He felt that, until it was proved that splenic anemia or Banti's disease could exist without evidence of obstruction to portal or splenic veins, this complex should not be considered a disease entity. He was unsuccessful in his attempt to reproduce the condition by experimental ligation of splenic vein—results also obtained by the writer in somewhat similar attempts. MacCallum did not feel that the splenic changes were such as are usually found with ordinary chronic passive congestion.

Attention soon turned to bacteriologic studies of the various splenomegalies, and many organisms were described as incidental or as constant causative factors. Some of these have been already mentioned.

Among the most interesting investigations now being made, aside from observations and impressions from clinical and statistical methods, is that of Eppinger [20] in Vienna, and Pearce, Krumbhaar and their co-workers [10] in Philadelphia. The spleen is no longer considered an isolated organ, but a part of a system, acting with the liver and the bone marrow. Eppinger was the sponsor for the theory of "hypersplenism," which, when introduced in 1913, reawakened surgical interest in this group of disease, and led to the wide use of splenectomy in hemolytic (pernicious) anemia. Pearce and Krumbhaar, by exact experimental work, are seeking to establish certain fundamental facts regarding the part of the spleen in this relationship.

Regarding the microscopic appearance of the spleens removed from this series of cases, little can be said. All correspond quite definitely to the picture described by Banti, MacCallum and recently by Chaney [12]

42. Warthin, A. S.: The Relation of Thrombophlebitis of the Portal and Splenic Veins to Splenic Anemia and Banti's Disease, Internat. Clin. **4**:189, 1910.

in the latest report on the Mayo clinic series. The reexamination microscopically has, however, been the means of eliminating several cases of hemolytic jaundice, which, in general, seems to show more dilatation of the venules, almost amounting to stasis, and pigmentation, with less fibrosis than typical splenic anemia.

Wilson,[43] in 1920, after a study of the excised spleens of the Mayo clinic series, concluded that the primary lesion is a hyperplasia, either lymphocytic or endothelial, later followed by degeneration and replacement by a secondary overgrowth of the stroma of the gland. He concludes also that this histopathalogic picture seems to be in complete harmony with the hypothesis of the presence of a slowly acting local toxin.

Chaney concluded that there are no very definite and well defined characteristics which enable the pathologist to say with certainty that the picture is one of splenic anemia. There is a variation within this group, but no greater than that found in other groups of splenic eniargement such as pernicious anemia or hemolytic jaundice, which are considered entities. In comparing the spleens of splenic anemia, myelogenous leukemia, pernicious anemia, hemolytic jaundice and syphilis, he finds that the tissue reactions are practically the same in their variations from normal in all groups in which fibrosis is associated. Chaney's conclusions tend to confirm the impression that the spleen plays the same rôle in all splenomegalic anemias. The microscopic picture is the result of the actual disease process, combined with the bodily attempt at healing by fibrosis.

ANALYSIS OF CASES

These thirty-five cases of splenic anemia have been studied from the point of view of etiology, pathology, the general results of splenectomy, the duration of symptoms, and the blood picture. Attempt was made to find some means of prognosis, with and without splenectomy, from a consideration of the bearing of these various factors on the end-results.

Etiology.—Although a known etiologic factor has hitherto removed any case from the category of splenic anemia, we have included several cases that offered the typical findings, which, in addition, gave evidence of association with some chronic condition whose relationship to splenic anemia has been suggested. Note may be made of the fact that this etiologic relationship is more often seen in the more acute forms of the disease, and that it is usually in these forms that one is least able to distinguish definitely the typical picture of pernicious anemia, hemolytic

43. Wilson, L. B.: The Pathology of Splenomegaly: A Study of the Operative and Autopsy Material from the Mayo Clinic, Surg., Gynec. & Obst. **16**: 240, 1913.

jaundice and splenic anemia. It is as though the processes were so accelerated and the picture so blurred that differentiation is usually made impossible. It is quite comparable to the situation often encountered in the acute forms of leukemia, lymphoid or myeloid.

An attempt has been made in the study of this series, to show the relationship of splenc anemia with one or more of the conditions which have been shown to have a casual connection with the syndrome. The case numbers and the associated condition are given, with a note concerning the results.

TABLE 1.—*Associated Conditions*

Conditions	Case No.	Course	Operation	Result
Syphilis	10	Progressive for ten years	No operation	Dead after two months
	12	Progressive for two years	No operation	Dead following an operation two years later
	13	Quiescent for five years; active recently	No operation	Dead after five years
	31	Typical splenic anemia	Splenectomy	Living after four years
Malaria	9	Quiescent, typical splenic anemia, Banti III	Excision specimen spleen for study	Living after eleven years
	16	Typical splenic anemia	Splenectomy	Postoperative death, hemorrhage
	17	Typical splenic anemia	Splenectomy	Well two years, then not heard from
	21	Typical splenic anemia	Splenectomy	Living, ten years
	1	Quiescent for twelve years; symptoms one year	No operation	Dead after two years
	4	Symptoms for two years	No operation	Dead after one year
	5	Typical splenic anemia with liver involvement	No operation	Not heard from
Tuberculosis, chronic (roentgen ray)	33	Atypical symptoms for two years	Splenectomy	Living three years, but not well
		Miscellaneous Infections		
Alveolar abscess, chronic tonsillitis, oral sepsis	26	Symptoms exacerbated by gestation; ascites	Splenectomy	Postoperative death, infection
Chronic tonsillitis, oral sepsis	25	Fairly rapid and atypical course	Splenectomy	Postoperative death, exhaustion
Mastoid and middle ear infection, endocarditis	32	Typical splenic anemia (child)	Splenectomy	Living four years; Streptococcus viridans found in blood during a later upset
Septic type of fever	22	More rapid than usual in a child	Splenectomy	Dead after eighteen months
Amebic dysentery	18	Typical course	Splenectomy	Well twenty years
Amebic dysentery	19	Typical course	Splenectomy	Dead after six months
Typhoid fever ? yellow fever ?	2	Anemia for four years	No operation	Living after thirteen years

Unfortunately, the number of cases is so small that any comparison of them with the remainder of the series, would yield very little information. The cases of splenectomy, primarily for malaria, syphilis, etc. are not included here. We are interested in the connection of these various disorders with a form of anemia, rather than in the splenic form of these disorders. This distinction is based on the conviction that this form of splenomegalic anemia, with its typical or atypical features, is the result, or clinical picture, which may be produced by the action on the hemolytopoietic apparatus of the various chronic conditions already mentioned. It will be observed that, while these conditions

are often present with a very typical form of splenic anemia, it is equally true that they often accompany an atypical or progressive form, which may have features of pernicious anemia or of hemolytic jaundice. This is, actually, as one would expect if one considers the activity of the underlying disorders as commensurate with the ease or probability of its detection and as proportionate with its demonstrable effect on the hemolytopoietic system.

Effect of Splenectomy on End-Results. General Results of Splenectomy.—Considerable information is to be gained by a comparison of the subsequent history of the group not operated upon, with that of the group in which splenectomy was performed.

TABLE 2.—*Comparison of Groups of Cases*

	Living, per Cent.	Dead, per Cent.	Postoperative Deaths, per Cent.	Patients Not Heard From, per Cent.
All patients	45.7	31.4 (Total 45.7)	14.3	8.6
Patients not operated on (13)	38.5	46.2	....	15.4
Patients operated on (22)	50.0	22.7	22.7	4.55

From this tabulation one sees that, of the cases not operated on, the difference in the number of those at present living and those who have since died is so small as to be readily affected by the percentage unheard from. On the other hand, the results in the group operated on are rather more definite. Of these patients, 50 per cent. are living, 22.7 per cent. died as a result of the operation and 22.7 per cent. died after leaving the hospital. The one patient not heard from (4.55 per cent.) would not appreciably affect this comparison. These figures are valuable only so far as they give a basis for further study of the cases. One is prompted to ask whether or not there were present any clinical features or particular characteristics in the patients not operated on which distinguished those who lived from those who died. Such features, if present, would assist in estimating the prognosis of any case when considering the type of treatment. Likewise, in considering the patients operated on, one may ask whether or not there might have been some features common to the 50 per cent. living which distinguished them from the 22.7 per cent. who died subsequently, or even from the 22.7 per cent. who died as a result of the operation. One may carry the comparison further and inquire whether or not there were any characteristics common to those who died after leaving the hospital, whether they were operated on or not. Such clinical data naturally would be of definite value in considering the treatment and estimating the prognosis in any given case of splenic anemia.

Comparison of the Improved and Unimproved Cases from the Standpoint of Duration, Type, and Acuteness of Symptoms.—The patients of Cases 2 and 3 were not sick. They showed only a slight

anemia, and their general health previous to a recent "anemic upset" had been good. In Case 8 there had been symptoms less than a year, consisting chiefly of epigastric pain, referable to the splenomegaly. The anemia was slight. In Case 9 there was only a slight anemia with

TABLE 3.—*Patients Not Operated On*

Case	Type	Living
2	2	13 years
3	2	13 years
8	2	18 years
9	2	11 years
11	1	6 months

a pronounced leukopenia and a history of ascites covering a period of nine years. In Case 11 there was a history of a fairly rapid process and anemia, which was not helped by any transfusions. The patient was definitely sick because of the anemia, as contrasted to Patients 2 and 3, and the outlook was undoubtedly bad.

TABLE 4.—*Patients Not Operated On*

Case	Type	Subsequent Death
1	2	2 years
4	1	1 year
6	1	2 years
10	2	2 months
12	2	1½ years
13	2	5 years

Cases 1 and 10 were alike in both patients having had a long history and both having given signs of liver involvement. Case 1 was more typical splenic anemia as regards the blood picture while Case 10 had some features of hemolytic jaundice and pernicious anemia. Cases 4 and 6 gave evidence of recent onset and rapid progress. In Cases 12 and 13, the patients had had symptoms longer than those of 4 and 6, but these symptoms had been noticeably growing worse. In Cases 10 and 12 some features of pernicious anemia were presented, and in 10, 12 and 13 there was a history of syphilis. The average duration of life of these six patients was about 2 years.

TABLE 5.—*Patients Operated On*

Case	Type	Living
14	2	25 years
17	2	2 years
18	2	20 years
21	2	10 years
23	2	9 years
27	2	5 years
30	2	4 years
31	2	4 years
32	2	4 years
33	1	2 years
34	2	14 months

In Cases 14, 17, 23, 27, 30, 31, and 32 there were attacks of hematemesis from a few months to five years before the operation. In none of these was the anemia extreme. In Cases 14, 30 and 32 there was hematemesis after the operation, but it was much less. In 23 and 30, the hematemesis had been the immediate reason for the patients seeking medical assistance; 18 and 32 were children under 10 years of age. In Case 21, there was a definite history of malaria. Case 33 was a more rapid type of disease. This patient was markedly anemic and had had symptoms referable to the anemia for two years. She suggested, in some ways, an atypical pernicious anemia or hemolytic jaundice. Splenectomy improved but did not cure her. In Case 34 there had been symptoms referable to splenomegaly for seven years and it represented a slower process than 33. The patient is in excellent health. In Case 17, the patient was well for two years, but was then lost track of. In Cases 27 and 30, note was made at operation of the scarred condition of the liver.

TABLE 6.—*Patients Operated On*

Case	Type	Subsequent Death
19	1	1 year
20	1	6 months
22	1	18 months
28	2	4 years
29	2	1 year

In Case 19, the patient was a child, who, although a gastric hemorrhage had occurred three years before admission, had shown signs of an "active anemia" before splenectomy. Death occurred after one year. Case 22 was also that of a child who had had symptoms referable to anemia for two years. Death occurred after eighteen months. Case 20 was of short duration, and an aleukemic lymphatic leukemia could not be definitely excluded. Death resulted in six months. Cases 28 and 29 were more the type of cases in which the patients are living. Both were over 5 years duration, and had had splenemegaly long enough to have had gastric hemorrhages. In both, the anemia was moderate. In Case 28 the patient lived four years, and in Case 29 death occurred after one year, following an operation for the relief of acute intestinal obstruction. The average duration of life in these patients who died subsequent to operation was one and one-half years, not very different from that of the group not operated on.

TABLE 7.—*Postoperative Deaths*

Case	Type	Cause of Postoperative Death
15	2	Rupture of esophageal varix
16	2	Intra-abdominal hemorrhage
24	2	Pneumonia
26	2	Peritonitis
35	1	Postoperative exhaustion

In Case 15 there was a stationary or chronic condition of eleven years' standing. In Case 16 there was also a long standing condition, in which there was a history of malaria nine years before the onset of the splenomegaly. Case 24, in comparison with cases of the cured series, was a very favorable case but the patient died of pneumonia. In Case 26 there was a history of chronic infection, with exacerbations of symptoms during gestation. In Case 35, there was a picture of a rapidly progressive process not clearly differentiated from pernicious anemia or from hemolytic jaundice.

From the foregoing study, it may be seen that the cases presented here may be grouped into two types, on the basis of their clinical course before admission to the hospital, the appearance on examination and the subsequent result. Type 1 will include those definitely sick and those complaining of symptoms directly referable to the severe anemia. The usual symptoms include pallor, weakness, languor, loss of weight, pain in the extremities or abdominal pain. Diarrhea is often a feature. In addition, an icteroid tint of the skin may be seen, or itching may be complained of. These symptoms may have completely overshadowed the abdominal picture, and the patient may be unaware of the splenomegaly. The duration of symptoms in this type is usually from six to eighteen months, although this may be superimposed on an older chronic process. Usually, patients suffering from this type of the disorder do not do well either with or without an operation. Of the five patients who died, an average period of one and one-half years after operation, three cases were of this type, and while the fourth patient has been slightly improved for two years, her physician reports her condition as unfavorable. Of seven patients not operated on, six died, an average period of about two years after discharge from the hospital, while the seventh is gradually losing ground. It seems then quite certain that this type of the disease in which the symptoms of anemia predominate over the abdominal symptoms and which has been of comparatively short duration, or in which the anemia becomes active in a chronic case, is usually fatal, and apparently uninfluenced in its course by splenectomy.

Type 2 includes all cases presenting the picture of a chronic process. The duration of symptoms need not necessarily be long, but it may be seen that the symptoms that bring the patient to the hospital, while possibly recent, are the result of a much longer underlying process, such as hemorrhage of the stomach from a gastric varix. In this type of the disorder, the symptoms referable to the splenomegaly, either with or without liver alteration, predominate in the picture, although there may be a few symptoms referable to the anemia such as weakness, loss of weight and pallor. There is rarely less than 2,500,000 red blood cells unless it is soon after a hemorrhage, and the anemia is

usually of a chlorotic type as contrasted with that seen in the more acute cases in which there may be some features of pernicious anemia. The splenomegaly may sometimes be related to a history of malaria as it was in Cases 1, 9, 16, 17 and 21. Children may be affected, and it is in these cases that one finds more often suggestive etiologic factors, as in Cases 18 and 32. Syphilis may be apparent in some cases, as it was in 10, 12, and 13. Tuberculosis may occur coincidently in those cases as shown by roentgen-ray examination, or there may be a definite history of a long continued infective process, such as oral and tonsillar infections. These cases are not invariably fatal. In Case 9, the patient was in good condition twenty years after the first development of ascites. In Cases 2, 3, and 8, the patients were seen early in the course of their disorder, but, according to the last report, they are living and apparently well. The patients not operated on and who have since died showed definite liver involvement such as was present in Cases 1 and 10, or they gave indication of developing activity as regards the anemizing process. In Cases 10, 12 and 13, the patients, giving syphilitic histories, were not operated on and subsequently died. Splenectomy does not always cure the condition. Case 28 is a typical chronic case, in which the patient died four years after the operation. In Case 19 the patient showed signs of recent activity just before operation, but died after six months. Case 29 may perhaps be considered a case of a cure following splenectomy, but the patient died after one year, following an operation for acute intestinal obstruction. The gastric hemorrhages, which are such a common feature, did not disappear, but are markedly improved in most cases, following splenectomy. In Case 33, the patient was improved but not cured, presenting some features of a more recurrent or intermittent activity than the remaining.

In this way, we see that every patient but one (Case 33) who is definitely cured or markedly improved after splenectomy was of the chronic type, and only two have subsequently died, one following an operation a year later. Those in whom splenectomy was of no benefit presented certain features that brought to mind atypical pernicious anemia or hemolytic jaundice. These include not only the cases of acute anemia of rapid course but also cases in which the symptoms of anemia are superimposed on the picture of a long standing splenomegaly.

Therefore, we may say that, in the chronic form of the disorder, in which the splenomegaly and related symptoms predominate, splenectomy is of considerable apparent value, although it is in this type of the condition that the operative difficulty is greatest. The operative mortality for this type of patient was 25 per cent. On the other hand, this type of the disorder is not invariably fatal without splenectomy, indicating that the apparent benefit conferred is not due to any indispensible effect on the underlying cause of the disorder. Naturally, there

is a great subjective improvement following removal of the abdominal mass, with the alleviation of such mechanical symptoms as hemorrhage, constipation, etc. This has been described as the clinical equivalent of a cure.

TABLE 8.—*Blood Examination*

	Red Blood Cells	Hemoglobin, per Cent.	Color Index	White Blood Cells
All cases	3,373,000	51	0.74	4,757
Splenectomized cases	3,452,000	50	0.70	4,578
Nonsplenectomized cases	3,240,000	53	0.81	5,060

TABLE 9.—*Blood Examination Reported by Other Observers*

	Red Blood Cells	Hemoglobin, per Cent.	Color Index	White Blood Cells
Osler,[38] 41 cases	3,425,000	..	Under 0.5	4,520
Griffin,[44] 18 cases	.....	Under 75	....	4,200
Chaney,[13] 60 cases	3,700,000	58	0.7	4,990

TABLE 10.—*Outline of Blood Examination of All Cases on Admission Grouped According to Duration and End-Results* *

Case	Red Blood Cells	Hemoglobin, per Cent.	Color Index, per Cent.	White Blood Cells	Type	End-Results
1	4,500,000	83	0.92	4 400	2	Dead two years
2	3,740,000	44	0.60	7,200	2	Living thirteen years
3	3,700,000	50	0.67	7,800	2	Living thirteen years
4	3,488,000	70	1.00	4,600	1	Dead one year
5	4,184,000	80	1.04	5,520	2	Not heard from
6	1,540,000	23	0.70	3,300	1	Dead two years
7	2,072 000	30	0.72	5.100	1	Not heard from
8	3 984 000	65	0.81	9,600	2	Living eighteen years
9	4,400,000	68	0.77	1,840	2	Living nine years
10	2.222 000	41	0.93	4.250	2	Dead two months
11	1.564 000	24	0.8	4,080	1	Living, unimproved six months
12	2,860,000	60	0.9	3,600	2	Dead eighteen months
13	3,856 000	55	0.7	4,500	2	Dead five years
14	4.754.000	57	0.58	6,428	2	Living twenty-five years
15	2,385 000	27	0.57	3,250	2	Postoperative death
16	3,334,000	28	0.42	2,400	2	Postoperative death
17	3,724,000	70	0.94	800	2	Living two years
18	3.800.000	45	0.60	10.700	2	Living fourteen years
19	3,170,000	50	0.76	7,800	1	Dead one year
20	4 000.000	70	0.87	3.500	1	Dead six months
21	2,450.000	55	0.95	5,000	2	Living twelve years
22	3.080,000	30	0.48	3.840	1	Dead one and one half years
23	2,900.000	36	0.6	2,200	2	Living nine years
24	4,344,000	72	0.82	2,500	2	Postoperative death
25	4.114,000	52	0.6	3,040	2	Not heard from
26	3.940,000	60	0.76	3,800	2	Postoperative death
27	4.112,000	68	0.82	5.000	2	Living five years
28	4,472.000	64	0.60	2,280	2	Dead four years
29	3.800,000	72	0.92	9 050	2	Dead one year
30	3,744,000	42	0.56	2,400	2	Living five years
31	3,024,000	35	0.57	3,400	2	Living four years
32	3,728,000	70	0.9	4,500	2	Living four years
33	2,000,000	30	0.75	2,000	1	Living two years
34	3,776,000	35	0.46	1,760	2	Living fourteen months
35	1,672,000	24	0.75	12,080	1	Postoperative death

* Splenectomy was performed in Cases 14 to 35, inclusive

Blood Examination.—An estimation of red blood cells, hemoglobin, color index, and white cells was made in all cases. The differential count of white cells was made in many cases. In many cases there

44. Griffin, H. Z.: Clinical Observations Concerning Twenty-Seven Cases of Splenectomy, Am. J. M. Sc. **145**:781, 1913.

were careful and complete studies of the blood at regular intervals both before and after operation. The latter are shown on charts.

TABLE 11.—*Possible Bearing of Color Index on the Ultimate Result* *

	Cases	Result
No Splenectomy		
Color index greater than 0.74	8	4 dead 2 living 1 living, unimproved 1 not heard from
Color index less than 0.74	5	2 dead 2 living 1 not heard from
Splenectomy		
Color index greater than 0.74	11	3 dead 5 living 3 postoperative deaths
Color index less than 0.74	11	2 dead 6 living 2 postoperative deaths 1 not heard from

* The average color index of the 35 cases was 0.74.

In the cases in which splenectomy is not performed, the prognosis is possibly better in those having a color index of less than 0.74. In cases in which splenectomy is performed, there is little difference in the ultimate results of the groups below or above 0.74.

TABLE 12.—*Possible Bearing of the White Blood Cell Count on Ultimate Results* *

	Cases	Result
No Splenectomy		
White blood cells below 4,750	8	6 dead 2 living
White blood cells above 4,750	5	3 living 2 not heard from
Splenectomy		
White blood cells below 4,750	14	7 living 3 subsequent deaths 3 postoperative deaths 1 not heard from
White blood cells above 4,750	8	4 living 2 subsequent deaths 2 postoperative deaths

* The average number of white blood cells of the 35 cases was 4,757.

If, in studying the blood examination, we arbitrarily set a definite dividing line between cases showing a moderate leukopenia, 5000-8000 white blood cells per cubic millimeter, and those showing a marked leukopenia, below 5,000, the average being 4,757, we note some interesting end-results. Of the nonsplenectomized group, six patients who had a marked leukopenia are dead, and two are living. Of those who had only a moderate leukopenia, three are living and well, while two have not been heard from.

Of the splenectomized group, the end-results are identical in those showing marked and in those showing only moderate leukopenia.

This would indicate that cases having a white blood cell count below 5,000 have a bad prognosis without splenectomy. That this is modified by the operation is seen from the fact that 50 per cent. of such patients operated on are living.

Cases in which the patient has a white blood cell count above 5,000 have a good prognosis without splenectomy. The prognosis with splenectomy in this group is good, but it is no better than that noted in those patients with marked leukopenia. The degree of erythropenia and percentage of hemoglobin, being affected by accidents, such as hemorrhage, has no apparent effect on the prognosis or the end-results.

There are three cases offering some difficulty in interpretation. These are Cases 8, 18 and 29. In Case 8 the patient had a white blood cell count of 9,600, and his symptoms were of ten months' duration. Splenectomy could not be done, so a gauze pack was introduced between the spleen and the diaphragm to stimulate adhesions. He has been in good health for eighteen years. In Case 18 there was a white blood cell count of 10,700. The patient was ten years old, and had had symptoms of splenic enlargement for one year. This picture suggests a transition stage between von Jaksch's and typical adult splenic anemia. Splenectomy was performed, and he has been well for more than fourteen years. In Case 29, there were symptoms covering a period of five years. The leukocytes numbered 9,050. Splenectomy was performed, and the patient was in good health for one year, when he died following an operation for the relief of acute intestinal obstruction caused by adhesions.

It has been found experimentally that the first reaction of the leukocytes, following the administration of an hemolysin, is a moderate or slight leukocytosis.[10] This leukocytosis is sooner or later followed by a leukopenia. Two patients who had symptoms for less than one year showed a slight negligible leukocytosis. One of the two was alive fourteen years after splenectomy. The other was alive eighteen years following an operation at which splenectomy was attempted but not accomplished. In the third case there were definite symptoms, including hemorrhage from the stomach for five years. This does not suggest an early case in spite of the normal or slightly elevated leukocytes. The patient progressed very well after splenectomy, but died after a year, following an operation for acute intestinal obstruction.

These cases do little more than suggest that a slight leukocytosis might signify an early stage of the disease, with responsive bone marrow, such as may be found in young individuals, particularly as seven other patients having symptoms of only a short duration had a slight and moderate leukopenia.

The Immediate and Late Results of Splenectomy on the Blood.—The most interesting case of this series is Case 14. This is the "Bow-

man Case" of Osler and of Cushing, which is illustrated in Figure 1. The blood was examined by Dr. R. H. Follis, a medical student at that time. The blood was markedly anemic six months before splenectomy with a pronounced leukopenia and a color index about 0.5. Under care and nursing this was improved up to the time of operation, but the color index remained persistently low. After operation, the most striking change was the leukocytosis of 30,000 occurring immediately, which was followed by the gradual return of the blood to normal after about a month. This was followed long enough to observe a second unexplained leukocytosis occurring during the fourth month and subsiding

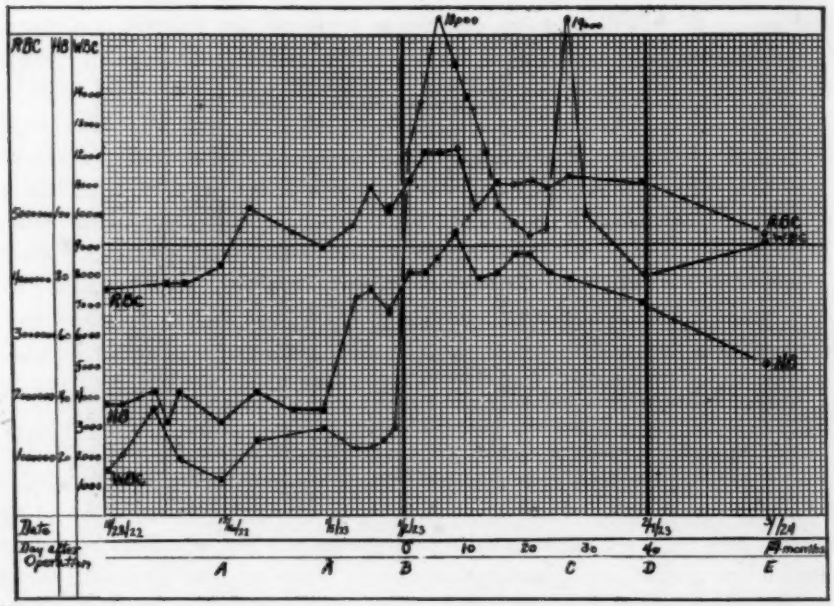

Fig. 2 (Case 34).—Blood observations: *A*, transfusion; *B*, splenectomy; *C*, incision-drainage-abscess; *D*, discharge; *E*, observation.

at the end of that month. The red cells behaved variably for ten days, first falling, then rapidly rising to 4,250,000, and finally, over a period of two months, slowly rising to normal. After three and a half months, the red cells numbered 5,000,000, and remained there until the patient's discharge, five months after operation. The hemoglobin content during the same period showed a corresponding rise, but the color index was always less than 0.7.

When the patient returned to the hospital for study, twenty-five years after splenectomy, there was a red cell count of 4,600,000 with 95 per cent. hemoglobin, and a color index of over 1. The white blood cells were practically normal, numbering 7,000. The differential formula

was normal except for slightly increased polymorphonuclear neutrophils and 5 per cent. eosinophils.

Figure 2 (Case 34) illustrates the same features following splenectomy. It is worthy of note that, while two pre-operative transfusions had considerable effect in disguising the anemia of the red cells, there was practically no effect on the white cells. Following splenectomy, there was the immediate sharp leukocytosis followed by a return to normal, which was complicated by a second leukocytosis coincident with an infection of the buttocks. This activity of the leukocytes after sple-

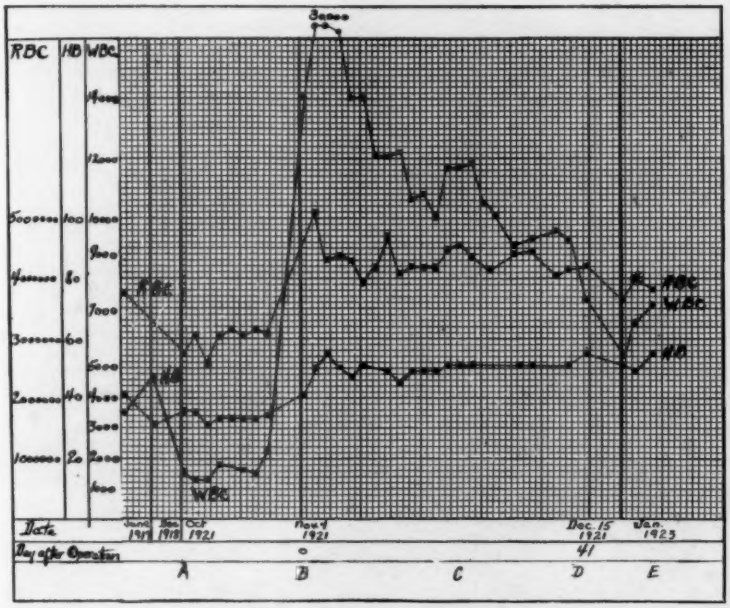

Fig. 3 (Case 33).—Blood observations: *A*, platelets, 152,000; *B*, splenectomy; *C*, platelets, 1,396,000; *D*, platelets, 960,000; *E*, transfusion.

nectomy seems a feature. The blood examination was also noted after fourteen months.

Figure 3 (Case 33) illustrates a case of pronounced leukopenia; there were 1,200 white cells, before operation. The postoperative blood changes were as usual, but on return for examination after two years there was a leukopenia of 4,800. The bone marrow however, was still responsive, demonstrated by a rise to 7,200, following a transfusion. Figure 4 illustrates the change in the differential formula after two years in this case, whose outcome is doubtful. There is a rather curious change here. The total number of leukocytes behaves quite characteristically, but the greatest change is in the decrease in polymorphonuclear cells with increased lymphocytes, large mononuclear and transitional

cells. This was apparently the same two years after splenectomy. A transfusion tended to restore the normal proportions. This patient's physician reported that three years afterwards she was still anemic.

Figure 5 (Case 31) illustrates the recovery after splenectomy, complicated by a gastric hemorrhage about twenty-four hours after operation. There was a progressive anemia lasting twelve days, after which the blood rapidly regained the normal picture. This patient is still living and well after three years.

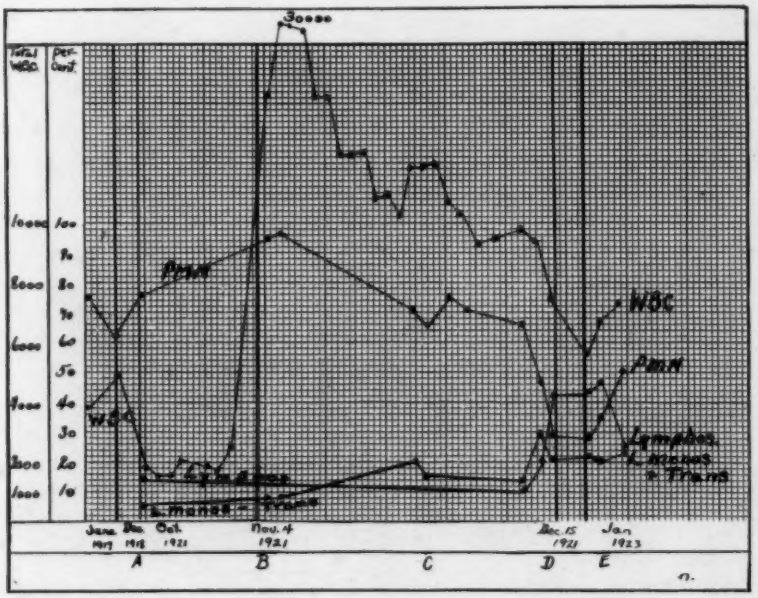

Fig. 4 (Case 33).—The change in the differential formula: *A*, platelets, 152,000; *B*, splenectomy; *C*, platelets, 1,396,000; *D*, platelets, 96,000; *E*, transfusion.

Figure 6 (Case 27) illustrates the excellent result obtained by splenectomy in a case of Banti's (second stage), and the result after five years. The anemia was not marked before operation, the red cells numbering 4,000,000 and there was 68 per cent. hemoglobin. After five years, there was a polycythemia of 6,330,000 with 90 per cent. hemoglobin. The color index was, however, less than before splenectomy (compare with Fig. 1). It will be interesting to note whether the color index will behave as it did in Case 14, in which a color index of over 1 was shown after twenty-five years. The leukocyte count was raised from 5,000 to 11,000 with a differential formula practically normal. Polycythemia is a not uncommon result when a normal or only slightly altered spleen is removed.

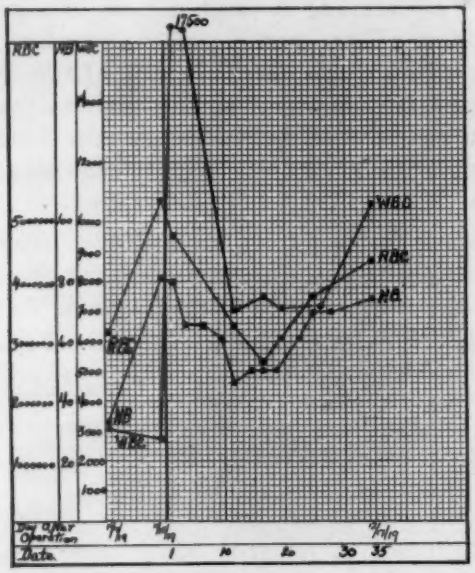

Fig. 5 (Case 31).—Blood observations illustrating the recovery after splenectomy.

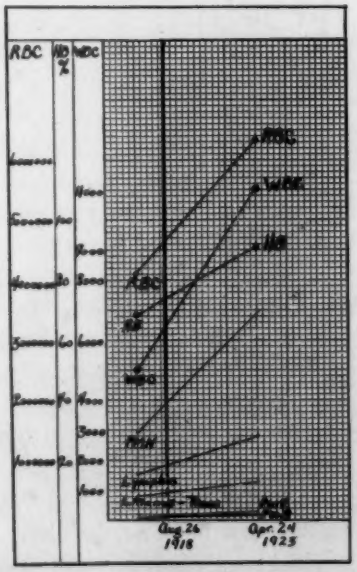

Fig 6 (Case 27).—Blood observations illustrating the results obtained by splenectomy in a case of Banti's disease (second stage).

In Figure 7 (Case 23) is illustrated the change seen nine years after splenectomy. There was present a secondary anemia of much less degree than before operation. The color index increased from 0.6 to 0.9, and the total number of white cells was normal. There had been a decrease in the polymorphonuclear cells from 70 per cent. to 56 per cent., and an increase in the small lymphocytes from 22 per cent. to 30 per cent.

Estimation of Prognosis from Clinical Data.—The foregoing analysis of these cases would indicate that there are several criteria which may be accepted as throwing considerable light on the prognosis of any given case of splenic anemia, either with or without splenectomy. Much

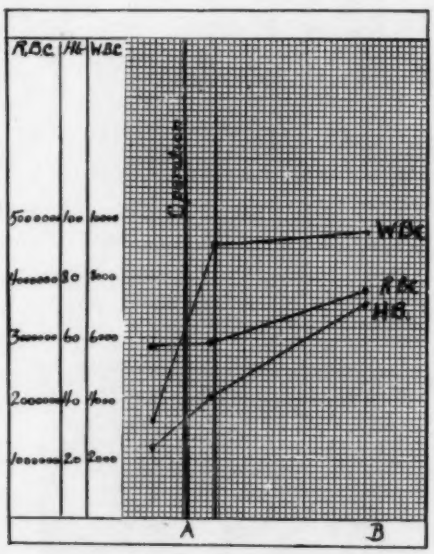

Fig. 7 (Case 23).—Results nine years after splenectomy: *A*, splenectomy, May, 1916; *B*, observation, April, 1924.

effort is usually spent in attempting to classify this given case as one of the three clinical types of hemolytic anemia. The typical cases of pernicious anemia and hemolytic jaundice usually offer no difficulty in diagnosis, and the prognosis in these disorders is well known.[45] The unsatisfactory results attending splenectomy in ten consecutive cases of pernicious anemia operated on between 1913 and 1918 has been noted previously in this report. The prognosis and diagnosis in typical and atypical splenic anemia has not been so definite. There are, however, various factors which yield much information regarding prognosis and treatment.

45. Elliott and Kanavel (Footnote 4); Krumbhaar (Footnote 1).

First, the duration of symptoms must be considered. As a rule, the degree of severity and acuteness of symptoms is in inverse proportions to their duration. This means that the patient whose symptoms, referable to anemia, have been present for less than a year, is suffering from much more rapid and uncompensated blood destruction than the patient whose symptoms of anemia have been overshadowed by the abdominal picture, or whose symptoms are referable to the mechanical effect of a slowly developing splenomegaly. Since it has been seen that these acute cases usually run their rapid and fatal course uninfluenced by splenectomy, one has some basis for deciding whether or not this operation should ever be advised. To go to the other extreme, one is nearly as skeptical in considering splenectomy definitely indicated for the patient who has had symptoms referable to the mechanical effects of splenomegaly for from five to fifteen years. It is true that we have here sixteen such patients operated on, ten of whom are well and apparently cured of the disorder. But we have seen that the disease is not invariably fatal without splenectomy, and that splenectomy should not be considered a specific cure nor even the means of doing away with symptoms. The most troublesome and common symptom was hemorrhage from the stomach, which was diminished but did not entirely disappear. Perhaps, in view of the 25 per cent. mortality in this type of case, due to the technical difficulties, one should not be so eager to consider splenectomy always indicated, particularly in the case of the patient who is not handicapped or invalided by mechanical effects.

The blood examination is an important item. The degree and type of anemia also gives information regarding the intensity of the disease process. The red blood cell count and the estimation of hemoglobin naturally indicate the grade of anemia, but are liable to variation because of the hemorrhage. The recovery after hemorrhage indicates, however, the degree of regenerative capacity of the blood-forming organs. The amount of hemoglobin and the color index suggest the type of anemia. We have seen how the approach to the pernicious type of anemia is marked by an increasingly poor prognosis. Naegeli [46] pointed out that the higher the color index, the worse the prognosis. Evans has noted that, in splenic anemia without hemorrhage, the color index was usually higher and tended to indicate splenic activity. The white blood cell count also is a measure of bone marrow activity, and indicates the response to the need of increased blood formation. This has led some observers [47] to consider the spleen as a depressant of bone marrow

46. Naegeli: Blutkrankheiten und Blutdiagnostik, Leipzig, 1912.

47. Hirschfeld, H.: Die Erkrankungen der Milz, Berlin, 1920. Klemperer, G., and Hirschfeld, H.: Milzextirpation zur Behandlung der perinösen Anämie, Therap. d. Gegenw. **54**:385, 1913.

activity and the cause of the anemia. In this series, a marked leukopenia usually suggested a poor prognosis. This was interesting in connection with an observation of Evans [48] that a remission in pernicious anemia could often be foretold by an increase in the white blood cell count. In addition to the gross examination of the blood, the platelet count also gives information as to the regenerative activity of the bone marrow. The examination for reticulated red blood cells and nucleated forms is another means of gaining definite information regarding bone marrow activity. Krumbhaar [10] finds the presence or absence of the former of valuable prognostic significance. The thorough blood examination is the means of estimating the response of the blood-forming tissue to the need of hyperactivity.

The test of the osmotic resistance of the red blood cells comes next. Although we do not know whether this test parallels or even approximates any similar condition in the body, it seems very probable that the finding of a decreased resistance to hypotonic salt solution, a decreased resistance that is the same for practically all other hemolysins (at least those affecting the cell envelope), indicates favorable conditions for excessive hemolysis. In the most typical case of our series, splenectomy markedly increased the resistance. This is in interesting contrast with the Spencer Wells case, reported by Dawson,[49] in which the patient had decreased resistance twenty-seven years after splenectomy for hemolytic jaundice.

The estimation of the urobilin content of both stool and urine offers the most accurate means of measuring the amount of blood destruction. This estimation was the basis for Eppinger's [13] work in determining the amount of normal blood destruction. The amount of urobilin usually present in the urine is so small that it is missed in the ordinary examination. In excessive blood destruction it is readily detectable, but, as Krumbhaar [10] pointed out, this need not necessarily be so, for the reason that the urobilinuria is in the nature of an overflow from the liver and may be absent when there are still greatly increased amounts in the stools; the amount of urobilinuria may also be influenced by a poorly functioning liver. With means of determining the total daily urobilin excretion, we may definitely learn the amount of blood destruction taking place within the body. The greatest increase is seen in pernicious anemia and hemolytic jaundice, while there is only slight increase in chronic splenic anemia.

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48. Evans, F. A.: Subjective Symptoms and the Differential White Blood Cell Count as Aids in Prognosis in Pernicious Anemia, Penn. M. J. **26**:228 (Jan.) 1923.

49. Dawson, Sir Bertrand: Discussion of Thursfields' "Splenectomy for Acholuric Jaundice," Proc. Roy. Soc. Med. (Clin. Sect.) **7**:86, 1914.

COMMENT

It has been pointed out that there are four features of the examination that yield very suggestive information regarding a case of splenic anemia, namely, the duration of symptoms, the blood examination, the red blood cell resistance, and the urobilin excretion. It becomes our task to correlate this with the information derived from experimental splenectomy, in order that we may have a more rational basis for the operative treatment of these cases. The three most prominent phenomena following splenectomy in normal dogs, as observed by Pearce, Krumbhaar and their co-workers [10] were a secondary anemia, an increased resistance of the red blood cells to various physical, chemical and biological agents, and a lessened tendency to hemoglobinuria and jaundice, after the administration of hemolytic agents.

The removal of a diseased spleen is not so noticeably followed by the development of anemia. One cannot say whether or not this is due to the removal of the diseased spleen per se or rather to the concentration of the blood following operative procedure. It has been suggested by Klemperer and Hirschfeld [50] that it is due to the removal of a depressant action on the bone marrow. Certainly after no other operation is there seen the immediate and profound leukocytosis that follows the removal of an enlarged spleen. Experimental postsplenectomy anemia reaches its severest stage after one and one-half months,[51] but clinically at this period, one sees the blood count well up. There is at no time an anemia more marked than that which existed before operation. After a short initial concentration of the blood, there is a slight anemia of about a week, followed by a steady increase in the number of red cells to normal or, in some cases, above normal. Obviously, the explanation for this cannot be derived from the behavior of the blood as seen experimentally, and this feature offers some basis for the belief that the spleen in its "hyperactivity" exercises a depressant effect on erythropoietic tissue.

The poor results following splenectomy in the acute and severe anemias, particularly in those that are pernicious in type, is probably explained by the fact that the operation does not remove the cause of the disease process. It was noted by Moffit [52] that the number of cases reported showing profound anemia was increasing and observation proves that it is this type of the disorder that is least influenced by the operation. Splenectomy may remove one and probably the chief site

50. Klemperer and Hirschfeld (Footnote 47, second reference).

51. Musser, J. H., Jr., and Krumbhaar, E. B.: The Relation of the Spleen to Blood Destruction and Regeneration and to Hemolytic Jaundice. VI, The Blood Picture at Various Periods After Splenectomy, J. Exper. M. **18**:487, 1913.

52. Moffit (Footnote 7, first reference).

of blood destruction, but the disease may continue practically unabated elsewhere in the body. In our experience, this constitutes one of the chief differences in the group of hemolytic anemias as a whole, and adds further weight to the existing evidence that pernicious anemia should be considered an entity. The early published reports concerning the good results following splenectomy in this condition were not based on observations of sufficient duration, as survivals of ten years are exceedingly rare. On the other hand, the good results following splenectomy in the other condition of splenic anemia and hemolytic jaundice do not necessarily indicate that the operation has removed the cause of the disease or even the chief site of blood destruction. One often sees, it is true, a clinical cure, but there are other explanations more in accord with experimental and clinical evidence. In considering anemia, one has to deal with the result of a disorder affecting any or all parts of the hemolytopoietic system. In the fatal type, the pernicious group, there is evident the greatest involvement; in the chronic or self-limited type, probably the least. It must be admitted, however, that, in the latter disorders, it is not the spleen alone which is involved.

With reference to the duration of symptoms, it is in the conditions of great chronicity that one finds signs of greatest splenic involvement as evidenced by the degree of splenomegaly. This would indicate that, with our present knowledge, the spleen is to be considered the part of the system earliest and most readily involved, but it does not prove that the splenic disorder is primarily at fault. The blood examination being the means of estimating the production of the erythropoietic tissue, we are able to judge the extent of the involvement of the entire function of blood production and to compare the end-results in the cases that are purely secondary (chlorotic) in type with those approaching the pernicious type. The most satisfactory results are seen in those least simulating pernicious anemia.

In the two types of anemia offering the best prognosis, chronic splenic anemia and hemolytic jaundice, one sees a great disparity in the results of examining the red blood cell resistance. The true significance of variation of resistance in health is not known. The examination, as it is commonly carried out with hypotonic saline solution, is a wholly artificial procedure, which parallels no condition found in the body, and which, therefore, can furnish no exact information regarding an obscure bodily activity. It has been claimed that other agents, such as immune serums or unsaturated fatty acids and soaps, offer methods which more nearly approximate conditions that may be found in the body, but these are not generally used. Since, however, the variation in resistance of the red cells has been found to be but slight between these different agents, it is reasonable to suppose that it does offer

some index to a bodily activity. When the resistance in the anemias is examined they may be classified as those having decreased resistance and those having normal or increased resistance. The latter group is found to include both pernicious anemia and splenic anemia. The former includes hemolytic jaundice, often called a disease of decreased resistance. The results of the examination of the resistance in pernicious and splenic anemia, according to most investigators, are much alike. It is usually stated to be normal or increased, occasionally decreased,[4] although according to Hill,[29] the resistance varies in any anemia, generally beginning at a higher and ending at a lower saline concentration. This classification on the basis of resistance is wholly insufficient in explaining the results seen after splenectomy. Included with those accompanied by normal or increased resistance are pernicious anemia and splenic anemia. Splenectomy may increase the resistance in either, sometimes markedly in the latter, but the outcome is fatal in the former, and a clinical cure results in the latter. If it is true that hemolytic jaundice is a disease of decreased resistance, one would expect a marked increase to accompany the clinical cure following splenectomy. But this is not always the case. The decreased resistance usually persists and has been reported present twenty-eight years following removal of the spleen.[49] There is a lack of agreement among the investigators who have worked for a solution of this problem. The findings of Banti and Furno of decreased resistance in blood from the splenic vein were not substantiated by Pearce and Krumbhaar,[10] nor were the latter prepared to support Bottazzi's theory, attributing a hematatonistic function to the spleen, which had been upheld by Banti and Furno. Pearce and Krumbhaar support the view that it is some factor intimately associated with the causation or repair of the anemia following splenectomy, and not the mere absence of the spleen, which is responsible for the increased resistance, and that this factor is operative in other anemias in the presence of the spleen. Against this view, however, may be offered the finding of marked increase in resistance without anemia, seen in Case 14 of this series twenty-five years after splenectomy. Unfortunately, the resistance before operation was not determined.

The conclusions we draw from experimental evidence regarding resistance should be modified by the fact that we cannot safely apply the conclusions derived from the removal of normal spleens from healthy animals, to the removal of diseased spleens from anemic patients.

There is apparently very little relation between the spleen and normal or increased resistance seen in splenic or pernicious anemia. In these conditions, the resistance is, as described by Pearce and Krumbhaar, a disturbance due to the anemia. Splenectomy, however, may

cause marked increase. In hemolytic jaundice, there is apparently a single explanation for the whole clinical picture in the relation between the splenomegaly and anemia and the decreased resistance, but curiously it is after splenectomy in this condition that the increase may be least marked. Further explanation is necessary, and the feeling is that erythrocyte resistance, as measured by present methods, is not an expression of the true cause of hemolytic anemia, but that it is the result of some blood mechanism as yet wholly unexplained.

In 1914, King,[53] working with Eppinger, pointed out the relation between the unsaturated fatty acids of the blood, as represented by the iodin number, and hemolysis. He also noted the relation between the blood lipoids and cholesterol and this hemolysis. The effect of splenectomy in causing an increase in these antihemolytic substances was offered as an explanation for the benefit derived from the operation. King suggested that the total increase of fats and lipoids following splenectomy may explain the increased resistance of the red blood cells found to accompany the condition of asplenism. Dubin and Pearce,[54] repeating this work, obtained results not in accord with Eppinger and King, and, while they feel that splenectomy has no influence on blood fat, they withhold a definite expression of opinion, inasmuch as feeding experiments performed by Anitschkow strongly suggested a possible relationship existing between the spleen and lipoid metabolism.

MacAdam and Shiskin,[55] in 1923, published their results of examinations of the cholesterol content of the blood in twenty-five cases, including pernicious anemia, splenic anemia and familial hemolytic jaundice. They point out that the cholesterol content of the blood is diminished in anemic conditions, and that after splenectomy in cases of acholuric jaundice and splenic anemia, there results a gradual but very considerable increase in the total cholesterol content of the blood plasma, while that of the corpuscles varies within a relatively narrow range.

Gibson and Howard,[56] however, felt that the unsaturated fatty acid content of the blood was not likely to be a factor causing hemolysis in pernicious anemia, and that the blood and plasma cholesterol figures were low in the cases with pronounced anemia and tended to increase

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53. King, J. H.: Studies in the Pathology of the Spleen, Arch. Int. Med. **14**:145 (Aug.) 1914.

54. Dubin and Pearce: Quoted by Pearce and Krumbhaar (Footnote 10).

55. MacAdam, W., and Shiskin, C.: The Cholesterol Content of the Blood in Anemia and Its Relation to Splenic Function, Quart. J. M., Oxford **16**:193 (April) 1923.

56. Gibson, R. B., and Howard, C. P.: Metabolic Studies in Pernicious Anemia, Arch. Int. Med. **32**:1-16 (July) 1923.

to normal with blood regeneration. Likewise Clark and Evans,[57] as a result of their experiments, did not feel that the diminished protective power against hemolysis of the serum in hemolytic anemia was to be explained simply on the basis of the diminution in the total cholesterin found in these conditions.

There were no blood lipoid or cholesterol determinations made in any case of this series before operation. Examinations were made in four patients who returned to the hospital for observation. In Case 14, twenty-five years after splenectomy there was normal blood, nearly three times the normal figures for cholesterol and total fat, and markedly increased red blood cell resistance. There was 340 mg. cholesterol per 100 c.c. blood (normal 140-180 mg.), and the total fat was 2.10 gm. per 100 c.c. of blood (normal 0.1-0.7 gms.). In Case 34, fourteen months after splenectomy, there was slight secondary anemia (hemoglobin, 50 per cent.; color index, 0.55), increased blood cholesterol (230 mg. per 100 c.c.) and increased red blood cell resistance. In Case 11, where the patient's condition was diagnosed as Banti's disease in 1912, and in whom splenectomy was not performed, the examination made in 1923 showed normal blood except for leukopenia (hemoglobin, 75 per cent.; color index, 0.7) decreased blood cholesterol (133.7 and 90.6 mg. per 100 c.c.), and normal red blood cell resistance. In Case 23, when the patient was examined nine years after the operation, there was a slight secondary anemia and a slightly increased resistance, within normal limits. Neither the resistance nor the cholesterol had been estimated previous to examination. The blood cholesterol at present is 260 mg. per 100 c.c.

Although the finding of increased blood formation, as shown by the demonstration of immature and nucleated forms in the circulatory blood, has been accepted as negative evidence of increased blood destruction, it has been of practically no quantitative value. The idea, originating with Tarchanoff [58] in 1874, that the bile pigments may furnish this information has been extensively developed. Eppinger and Charnas,[18] Brugsch and Retzloff,[59] Wilbur and Addis,[60] and Robertson [61] have shown that the urobilin output closely parallels the rate of

57. Clark, H. M., and Evans, F. A.: Studies with Lecithin and Cholesterin in Relation to the Anti-Hemolytic Property of Human Serum, Bull. Johns Hopkins Hosp. **32**:113, 1921.

58. Tarchanoff, F.: Ueber die Bildung von Gallenpigment und Blutfarbstoff im Thierkorper, Arch. f. d. ges. Physiol. **53**:329, 1874.

59. Brugsch, T., and Retzloff, K.: Blutzerfall, Galle und Urobilin, Zur Frage Gallenfarbstoffbildung aus Blut., mitt. III, Ztschr. f. exper. Path. u. Therap. **11**: 508, 1912.

60. Wilbur, R. L., and Addis, T.: Urobilin, Its Clinical Significance, Arch. Int. Med. **13**:235 (Feb.) 1914.

61. Robertson, O.: Urobilin in the Stool, An Index to Blood Destruction, Arch. Int. Med. **15**:1072 (June) 1915.

blood destruction in health and disease, and it is from this determination that we may draw conclusions regarding the quantitative degree of the disease process. The value of this determination as a means of accurate estimation has lately been discussed by Peyton Rous.[62] However, as a means of clinical examination, the urobilin output in the stool and urine when controlled for a sufficiently long period yields considerable information. It has been found that the highest urobilin control of the stool and urine is seen in the conditions with the greatest apparent destruction, hemolytic jaundice and pernicious anemia. The amount seen in chronic splenic anemia may be much less. Eppinger and Ranzi [20] have recommended splenectomy in all cases showing this evidence of increased blood destruction, on the ground that there is a marked reduction in the stool urobilin following the operation. Balfour [63] approaching the problem clinically, felt that the activity of the disease is an important consideration in discussing the advisability of the operation. Morawitz [64] felt that splenectomy was indicated in the presence of abnormal hemolysis, and if the patient's ability to work and his comfort are interfered with. Pearce and Krumbhaar [10] feel that the urobilin and urbilinogen output afford an approximate idea of blood destruction, and their results show that there may be a reduction of six-sevenths of this amount following splenectomy in hemolytic jaundice and pernicious anemia. Robertson [65] noted a similar reduction and felt that such a finding, when permanent, suggested a favorable prognosis. The mechanism of this reduction is not understood. Austin and Pepper [66] showed that at least part of the change is due to the disturbance in the portal circulation, wherein the amount of portal blood is decreased, and which may be simulated by ligation of the splenic veins or a transplantation of the splenic or portal veins into the vena cava. While it would be unwise to accept the finding of increased urobilin excretion as the outstanding indication for splenectomy, we are safe in regarding the estimation as a valuable index of the rate of blood destruction, and therefore a method of determining the benefit derived from treatment, splenectomy or otherwise.

CONCLUSION

Thirty-five cases of splenic anemia are presented, including the syndrome described by Osler under the name of anemia splenica chronica. In addition to this syndrome of unknown etiology, cases

62. Rous (Footnote 19, second reference).

63. Balfour, D. J.: Indications for Splenectomy in Certain Chronic Blood Disorders, J. A. M. A. **67**:790 (Sept. 9) 1916.

64. Morawitz (Footnote 7, second reference).

65. Robertson (Footnotes 61 and 30).

66. Austin, J. H., and Pepper, O. H. P.: The Relation of the Spleen to Blood Destruction and Regeneration and to Hemolytic Jaundice, XXII, The Importance in the Production of Hemolytic Jaundice of the Path of Hemoglobin to the Liver, J. Exper. M. **22**:675, 1915.

clinically identical, but with a suggestive etiology are also included. The purpose of the study is to investigate the end-results seen in these cases of anemia with splenomegaly which do not show the typical characteristics of pernicious anemia or hemolytic jaundice, and from a comparison of the results seen both with and without splenectomy, draw conclusions regarding the benefit derived from the operation. It was felt that the presence of a suggested etiology was not in itself a sufficient reason to withdraw a case from a clinically identical group and, for this reason, the cases were considered as disorders that may be brought about by the action of various factors on the hemolytopoietic system. In selecting cases for study, it was noted that there were several running a more rapid course and presenting some of the features of pernicious anemia or hemolytic jaundice, which were thought to represent an acute condition of the syndrome described by Osler.

The results noted in these atypical cases, which approached pernicious anemia, suggested a brief resumé of the results noted in typical cases of the latter condition. Accordingly, the end-results seen in ten consecutive cases of splenectomy for the condition performed between 1913 and 1916 are given. The mortality in these ten cases was 30 per cent.; five patients died an average period of fourteen months after the operation, and two were not heard from.

The reports of the thirty-five cases are given in detail and summarized. In twenty-two patients, the spleen was removed. The reports include all positive and the important negative findings. The blood examination for a long postoperative period is given in several. A brief description is included of the excised spleen. One patient, the Bowman case of Osler, Cushing and MacCallum, was examined twenty-five years after splenectomy.

The question of etiology is discussed from the standpoint of the general etiologic causes of anemia. It is suggested that anemias of increased blood destruction tend to present clinical pictures depending on the portion involved, and the extent of involvement of the hematophagic tissue of the body. Therefore, while these clinical pictures usually occur in the forms of typical pernicious anemia, hemolytic jaundice and splenic anemia (Banti's disease), there may be intermediate and transitional forms in which an accurate classification is extremely difficult or even impossible. It is in the latter forms, which may run a more rapid course, that the causative factor is more often apparent; this is to be expected if one considers the severity of the underlying disorder as commensurate with the ease or probability of its detection, and as proportionate to its effect on the hemolytopoietic system.

The significance of syphilis, malaria, tuberculosis, rickets and many other chronic infections and disorders as causative factors is considered. These conditions may bring about an anemia with splenomegaly, identical with similar anemias of unknown etiology.

The pathology of the spleen is described, and the danger of drawing conclusions from this is pointed out. The changes seen in all fibrotic splenomegalies are very similar, usually differing only in degree, and are seen in many conditions of known and unknown etiology. The process is to be considered as the result of an attempt at healing, or a defense reaction against the disease process. This "fibro-adenie" suggests a splenic hyperactivity, which may in part be responsible for the result seen as anemia.

The cases reported have been studied from the point of view of etiology, pathology, the general results of splenectomy, the duration of symptoms and the blood picture. Attempt was made to find some means of prognosis with and without splenectomy, from a consideration of the bearing of these various factors on the late end-results.

TABLE 13.—*The Results Seen in the Thirty-Five Cases*

	Living, per Cent.	Dead, per Cent.	Postoperative Death, per Cent.	Not Heard From, per Cent.
Patients not operated on (13)	38.5	46.2	....	15.4
Patients operated on (22)	50.0	22.7	22.7	4.5

These figures are used as a basis for further study, and attempt is made to find any clinical features or particular characteristics in the cases not operated on, which might otherwise distinguish those who lived from those who died. Likewise, in the group of patients operated on, an attempt was made to find any features common to the 50 per cent. living, which would otherwise distinguish them from the 22.7 per cent. who died subsequently, or even from the 22.7 per cent. who died as a result of the operation. Such clinical data would be of considerable value in discussing the treatment and estimating the prognosis in any given case of splenic anemia.

On the basis of end-results, the clinical course before admission to the hospital and the appearance on examination, the cases may be placed in two groups.

The first includes those patients who are definitely ill, and who complained of symptoms directly referable to the anemia. The duration of symptoms may be from six to eighteen months, or this period of activity may be superimposed on a much older chronic process. The end-results indicate that this type of the disorder is usually fatal and apparently uninfluenced in its course by splenectomy.

The second group includes all cases presenting the picture of a chronic process. Although the actual symptoms that bring the patient to the hospital may have been of recent onset, they are usually the result of a much longer underlying condition. There may be a few symptoms referable to anemia. Splenectomy is of considerable apparent value, although it is in this type of the condition that the operative

difficulty is greatest. On the other hand, this type of the disorder is not invariably fatal without splenectomy, nor does splenectomy always cure the condition, indicating that the apparent benefit conferred is not due to any indispensible effect on the underlying cause of the disorder. Following splenectomy, there may be a great subjective improvement, with the alleviation of such mechanical symptoms as gastric hemorrhages, constipation, etc. This has been described as the clinical equivalent of a cure.

The average blood picture seen was: red blood cells, 3,373,000; hemoglobin, 51 per cent.; color index, 0.74, and white blood cells, 4,757. The differential count was normal except for a slight decrease in the number of polymorphonuclear cells. This corresponds closely with the figures given by other observers.

In the cases in which splenectomy is not performed, the prognosis is possibly better in those in whom the color index was less than the average 0.74. The nearer the color index of pernicious anemia is approached, the poorer becomes the prognosis. In cases in which splenectomy is performed, there is little difference in the ultimate results in the groups below or above 0.74.

If we consider a white blood cell count of 5,000 as a dividing line between a moderate and a marked leukopenia, we observe that cases having a marked leukopenia have a bad prognosis without splenectomy, and that this is modified by the operation is seen from the fact that 50 per cent. of such patients are living. Cases having a moderate leukopenia have a good prognosis without splenectomy, while the prognosis with the operation is no better than that observed in the cases with a marked leukopenia.

We must except from this rule those acute and usually fatal cases which may have a normal or slightly increased number of white blood cells. The fact that the degree of erythropenia and the percentage of hemoglobin is readily affected by accidents such as hemorrhage, has no apparent effect on the prognosis or on the end-results.

The effect of the removal of a diseased spleen on the blood in anemia is dissimilar to the effect of removal of a healthy spleen on normal blood, as seen in experimental animals. There is an immediate and great increase in the white blood cell count, which gradually returns to normal over a period of a month. There is also an immediate rise in the red blood cell count continuing for a weak, after which there is a fall followed by a gradual increase, the count becoming normal after about ten weeks. The immediate rise in the red blood cell count, possibly the result of postoperative blood concentration, is not accompanied by a corresponding increase of hemoglobin, whose increase follows the second slower increase in the number of red cells. After a long period (twenty-five years) the color index may be over 1. Splenectomy, in this condition, may be the cause of a late (five years) polycythemia.

The favorable cases are usually accompanied by a return to a normal white blood cell count, in which the differential proportions are also normal. In the unfavorable cases, one may see a low normal total number with a decrease in the polymorphonuclear cells and increased lymphocytes.

The prognosis in these cases may be indicated by a study of the duration of symptoms and the blood examination, as noted above. In addition, the estimation of the osmotic resistance of the red blood cells may be helpful. Although a clinical cure is often seen following splenectomy in the disorder known as a disease of decreased resistance, or hemolytic jaundice, it may not always be accompanied by a postoperative increase of resistance. The resistance in splenic anemia is not constant; there is usually an alteration in any anemia. In the most typical case of this series, a greatly increased resistance was found twenty-five years after splenectomy.

A marked increase of urobilin and urobilinogen in the stool and urine, while indicating greatly increased blood destruction, is not necessarily a constant indication for splenectomy. It is seen not only in the type amenable to splenectomy, namely, hemolytic jaundice, but also in pernicious anemia in which the operation does not seem to improve the prognosis. A permanent decrease in the output following splenectomy suggests a favorable prognosis.

Although the experiments of Eppinger and King, who found in the blood following splenectomy a decrease in the iodin number corresponding to the amount of unsaturated fatty acids, and an increase in the antihemolytic substances, lipoids and cholesterol, were not substantiated by Pearce, Krumbhaar and their co-workers, we have found in one case the cholesterol and total fats trebled twenty-five years after splenectomy and, in three other cases, a milder increase, all accompanied by increased resistance of the red blood cells. It is possible that this determination will also shed further light on prognosis.

Statistical studies of these and allied conditions are handicapped by insufficient data both in hospital records and reported cases. It would be of great assistance to investigators if the available clinical data included a painstaking search for etiologic factors in the anamnesis, Wassermann reactions both before and after provocative doses of arsphenamin, gastric analyses, urine and stool examinations, roentgen-ray examination of the chest, complete blood examination and determinations of the osmotic resistance of the red blood cells. To these may be added the microscopic examination of an excised lymph-node, the estimation of the blood lipoids and cholesterol and the amount of urobilinogen output in stools and urine over sufficiently long periods of time. When such information is accumulated in a large number of cases, our clinical studies of anemia will yield more valuable results.

SPLANCHNIC ANESTHESIA: AN ANALYSIS OF FORTY-TWO CASES

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On the whole, recent literature indicates a vastly widening appreciation of the advantages of local anesthesia. With the general improvement in anesthetic drugs and in the technic as applied to any one operation, many major operations are now performed under local anesthesia. Indications and demands for its use have steadily increased until, in certain fields of surgery, it is regarded as the method of choice, and has been adopted.

Local anesthesia is not of like value in all branches of surgery. On account of the superficial position of the parts, the anatomic arrangement, and the course and distribution of the nerves involved, inguinal herniotomy [1] is probably the most common major operation performed by this method. For similar reasons, operations on the neck may be very efficiently and painlessly performed without general narcosis,[2] whereas block of the sacral nerves affords a very satisfactory anesthesia of the pelvic floor and viscera.[3]

Many difficulties, however, may attend the performance of a complicated or extensive operation within the abdominal cavity,[4] and no operation can be undertaken with certainty of success by local methods alone, unless limited to those parts in contact with the abdominal walls or quite readily accessible, which are not acutely inflamed and can be operated on without undue traction or manipulation.[5] Surgeons, therefore, have been less prone to use local anesthesia in abdominal surgery, and laparotomies are usually performed under general as well as local anesthesia, if intra-abdominal work is required.[6]

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1. Labat, G., and Meeker, W. R.: Inguinal Herniotomy Under Regional Anesthesia, Surg., Gynec. & Obst. **34**:398-403 (March) 1922.

2. Meeker, W. R., and Hundling, H. W.: Local Anesthesia in Operations on the Neck, Surg., Gynec. & Obst. (in press).

3. Meeker, W. R., and Frazer, E. B.: Transsacral Nerve Block Anesthesia in Surgery of the Pelvic Floor and Viscera, Surg., Gynec. & Obst. **35**:801-812 (Dec.) 1922.

4. Harris, M. E.: Local Anesthesia. Operations on the Abdomen, Oxford Surgery, London, Oxford Univ. Press **1**:130-135, 1920.

5. Meeker, W. R.: The Use of Paravertebral Nerve Block Anesthesia in General Surgery, Minnesota Med. **6**:138-152 (March) 1923.

6. Hertzler, A. E.: Operations with Local Anesthesia. In: Abdominal Operations. 2 Ed., New York, Surgical Publishing Company, 1916, pp. 161-181. Howitt, H. O.: Some Work with Block and Local Anesthesia, Canad. M. A. J. **12**:549-553 (Aug.) 1922.

For every abdominal operation, it is essential to use local anesthesia first for the laparotomy. Intra-abdominal anesthesia is also desirable to facilitate dealing with the diseased viscus, although it must be conceded that many more abdominal operations have been performed satisfactorily without intra-abdominal anesthesia than with any of the present-day alleged methods of blocking painful impressions from the abdominal cavity.[7]

PARAVERTEBRAL NERVE BLOCK

It was originally hoped that, in bilateral paravertebral nerve block, a practical method of anesthesia for abdominal operations had been evolved.[8] The work of Braun,[9] Finsterer,[10] Pauchet,[11] Kappis,[12] and others on this subject has been particularly thorough and comprehensive. After a complete trial, these men have entirely abandoned the method for abdominal surgery. The disadvantages seem to preponderate greatly over the advantages. As is quite evident from anatomic consideration, the technic is highly complicated, time consuming and tedious, which would not, in itself, be a disadvantage if anesthesia were not so often incomplete and never produced the type of "abdominal silence" resulting from the use of ether narcosis or spinal anesthesia. For this reason, the few surgeons who still occasionally employ this method must induce deep preliminary morphin-scopolamin narcosis and often smooth over an insufficient nerve block anesthesia by local infiltration and a few

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7. Farr, R. E.: Abdominal Operations Under Local Anesthesia, J. A. M. A. **73**:391-395 (Aug. 9) 1919; A System of Applying Local Anesthesia, Illinois M. J. **42**:101-104 (Aug.) 1922; Practical Local Anesthesia; Splanchnic Anesthesia, Philadelphia, Lea & Febiger, 1923, pp. 123-129. Skillern, P. G.: Abdominal Operations Under Local Anesthesia, Am. J. Surg. **36**:97-194 (May) 1922. Stevens, C. A.: Local Anesthesia in Abdominal Surgery, Illinois M. J. **39**:486-489 (June) 1921.

8. Adam, L.: Ueber die Anästhesieurung der Bauchhöhle, Deutsch. Ztschr. f. Chir. **133**:1-24, 1915.

9. Braun, H.: Oertliche Betäubung ihre wissenschaftlichen Grundlagen und praktische Anwendung, Leipzig, Barth, 5te Auf., 1919, 354-356; Die Grenzen der örtlichen Betäubung, Arch. f. klin. Chir. **116**:185-200 (July 21) 1921; Ein Hilfsintrument zur Ausfuhrung der Splanchnicus Anästhesie, Zentralbl. f. Chir. **42**:1544, 1915.

10. Finsterer, H.: Improvement in the Various Methods of Local Anesthesia for Extensive Abdominal Operation, Am. J. Surg. **35**:205-208 (July) 1921; Anesthesia in Abdominal Surgery, Nev York, Rebman, 1923, pp. 65-92.

11. Pauchet, V.; Sourdat, P., and Labat, G.: L'anesthesie regionale, Ed. 3, Paris, Doin, 1921, pp. 103-123.

12. Kappis, M.: Ueber die Sensibilität und die lokale Anästhesie im chirurgischen Gebiet der Bauchhöhle, München. med. Wchnschr. **2**:1200, 1918; Die Anästhesierung des Nervus splanchnicus, Zentralbl. f. Chir. **45**:709-710, 1918; Sensibilität und lokale Anësthesie im mit besonderer Berücksichtigung der Splanchnikusanästhesie, Beitr. z. klin. Chir. **115**:161-190, 1919.

whiffs of ether or nitrous oxid-oxygen analgesia. The deep, and by no means painless, injections have to be made from several points. Kappis and Pauchet injected twenty-two spinal nerves, while Labat [13] reduced the number to twelve for upper abdominal surgery. Often repeated search in the same interspace must be made, and the field tested and reinjected even by the most expert, making the procedure an extensive surgical operation in itself. Indeed, the patient undergoing an operation under paravertebral nerve block anesthesia may quite properly be regarded as having two operations, the first, paravertebral nerve block, being performed without anesthesia. The technical difficulty in blocking a spinal nerve is certainly greater than lumbar puncture. If one imagines lumbar puncture performed twenty-two times preliminary to operation, he will realize the comparatively severe demands on the psyche of the patient. The term "shockless surgery" applied to such a procedure is certainly a misnomer. The injections are not free from risk, and toxic symptoms are often produced by the large amount of solution employed. It is not surprising, then, that no rivalry exists between bilateral paravertebral nerve block and general anesthesia for abdominal operations.[14]

SPLANCHNIC NERVE BLOCK

More recently experiments have been made to interrupt conductivity in the splanchnic nerves, and the pioneers in this work are the same who formerly advocated paravertebral nerve block. Kappis has devised and employed a method of blocking splanchnic nerves from behind. Slight modifications have been made since by others, but they are of such a minor nature that Kappis is recognized as having devised the posterior route as employed today.

Technic.—The patient lies in a lateral position with the back arched, the knees flexed and drawn up toward the chin. A cushion is slipped under the loin to keep the spine straight, and thus make the technic more accurate. The twelfth rib is palpated and a wheal raised on its lower border, 7 cm. from the middle line of the spine. With a longer needle, from 10 to 15 cm. in length, depending on the size of the patient, search is made for the lateral surface of the first lumbar vertebra. The needle is inserted through the anesthetized skin, and passes below the twelfth rib inclined toward the spine at an angle of from 30 to 45 degrees with the median sagittal plane. Its point then strikes the lateral

13. Labat, G.: Regional Anesthesia with Special Reference to Splanchnic Analgesia, Brit. J. Surg. **8**:278-284 (Jan.) 1921; Regional Anesthesia, Philadelphia, Saunders, 1922, pp. 224-246. 348-362.

14. Bartlett, W.: An Estimate of the Value of Local Anesthesia in the Surgery of Today, Surg., Gynec. and Obst. **33**:27-37 (July) 1921.

aspect of the first lumbar vertebra in front of the intervertebral foramina and within the substance of the psoas muscle. This point is behind the splanchnic nerves at about the level at which they join the semilunar ganglion. The needle is now withdrawn and reinserted somewhat more obliquely outward, thus increasing the angle until the needle is tangent to the vertebra. At the moment the needle no longer encounters an obstacle but just grazes the vertebral body, the operator feels it passing through the muscular mass and entering a free space, the paravertebral cellular tissue (Fig. 1). The needle should not be pushed farther than 1 cm. after its point is felt gliding past the vertebral margin. At this point, from 30 to 50 c.c. of a 1 per cent. procain-epinephrin solution is injected into the cellular tissue in which the splanchnic nerves and semilunar ganglion lie (Fig. 2), this procedure being repeated on the opposite side. Kappis originally injected at three points on each side, but has since reduced the number of punctures, so that the technic as described is that known as the posterior route of Kappis, which is commonly employed by those using the splanchnic method.[15]

Splanchnic nerves may also be anesthetized from in front. Wendling[16] anesthetized the splanchnic region thus through the intact abdominal wall. Credit is usually given Braun[9] for injection of the splanchnic nerves from in front after exposure of the stomach and lesser omentum by laparotomy.

Wendling[16] first infiltrated the abdominal wall as for laparotomy. He then selected a point 1 cm. below and 0.5 cm. to the left of the tip of the ensiform process. The needle, inserted vertically at this point, after passing through the abdominal wall pierces the left lobe of the liver and lesser omentum and reaches the vertebral column, usually at a depth of 6 cm. From 50 to 80 c.c of procain-epinephrin solution is then slowly injected. The needle should be 9 or 10 cm. long, have a rather blunt, short bevel and be of small gauge. Wendling warns against intravenous injection in the vascular regions, as he observed procain intoxication in one case from accidental injection into a vein.

Braun first anesthetizes the abdominal wall by distributing the 0.5 per cent. solution along the costal and lateral margins of the recti muscles. A middle line incision is then made. The left hepatic lobe is

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15. Metge, E.: Erfahrungen an hundert Splanchnikusanästhesien nach Kappis, Deutsch. Ztschr. f. Chir. **178**:37-59, 1923. Mirizzi, P. L.: Anestesia esplancnica, Rev. med. d. Rossario **12**:347-348, 1922. Nolle: Zur Splanchnikusanästhesie, Deutsch. med. Wchnschr. **46**:737 (July 1) 1920. Graf, P.: Zur Splanchnicusbetäubung nach Kappis, Zentralbl. f. Chir. **48**:298-301 (March 5) 1921.

16. Wendling, H.: Ausschaltung der Nervi splanchnici durch Leitungsanästhesie bei Magenoperationen und anderen Eingriffen in der oberen Bauchhöhle, Beitr. z. klin. Chir. **110**:517-550, 1918.

carefully lifted up with a flat retractor, the stomach pushed slightly to the left and the hand passed into the abdominal cavity. With the finger tips one feels the anterior surface of the first lumbar vertebra which is situated at the level of the ensiform process. The pulsating aorta is pushed to the left, the finger resting on the lateral anterior surface of the vertebral body covered here by only a thin layer of soft parts, the insertion of the diaphragm and the posterior peritoneum. A needle is then introduced along the finger to the bone, and from 30 to 50 c.c. of a 1 per cent. solution is slowly injected. In like manner, the right lateral aspect of the first lumbar vertebra is identified and the needle

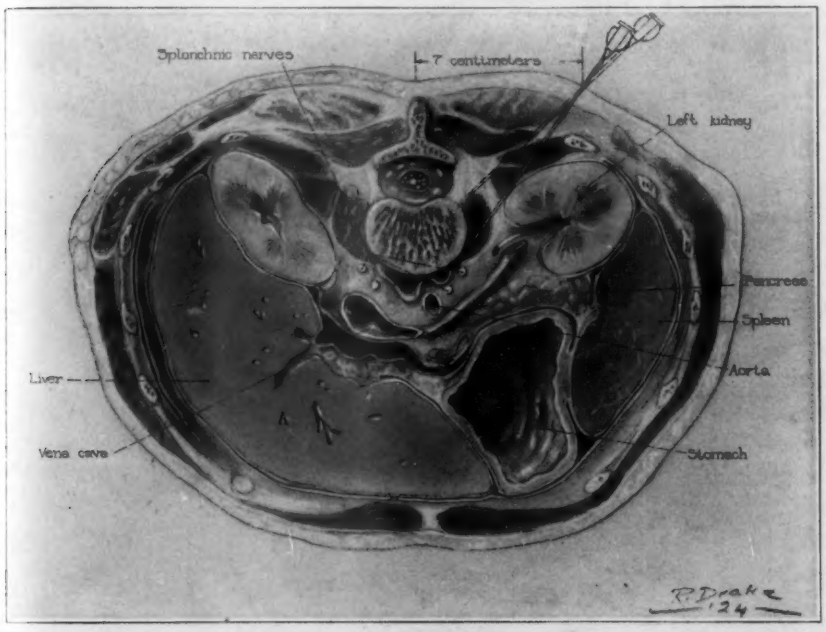

Fig. 1.—Cross-section through the first lumbar vertebra showing the Kappis method of splanchnic nerve block; the injection is made with the needle tangent to the body of the vertebra (modified from Labat).

reintroduced in close contact with the bone, and the injection made. Braun sometimes makes only one injection on the middle line over the body of the first lumbar vertebra. All manipulations should, of course, be gentle. Pulling of the lesser omentum, spreading of the abdominal wound and examination of the cavity must be avoided.

Wendling's method of splanchnic nerve block has never been adopted. Experiments on the cadaver show that it is almost impossible to reach the splanchnics through the intact abdominal wall without injury. The position of the upper abdominal organs with respect to each other is quite inconstant. There may be such marked changes in relative position as a result of inflammation and adhesions that even

the transverse colon may be struck by the needle. Because of these dangers, it is safe to predict that this method will never be of any value. When the anterior route is preferred, the Braun method of injection after the abdomen is opened is the one usually employed.

Both the Kappis and Braun methods have had a fairly thorough trial, each having its advocates. Judged from the frequency of its employment, the Kappis method is probably more practical than the

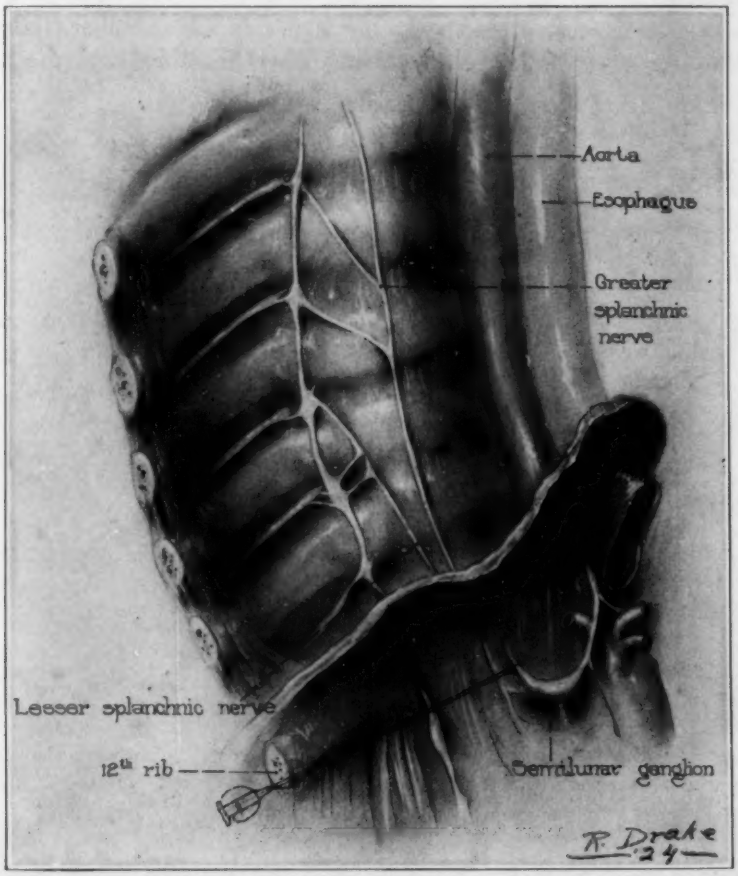

Fig. 2.—Direction of the needle in reaching the right splanchnic nerves at the level of the first lumbar vertebra.

Braun. The posterior method is easier and safer than the anterior because of anatomic relationships. Practice on the cadaver indicates that there is no danger of puncture of the aorta, vena cava or renal vessels when close contact with the surface of the vertebra is maintained. Far from being a blind method, as it might at first appear, it is fairly precise, the difficulty, of course, increasing with obesity and deformity. Certain surgeons do not favor the anterior method because of the difficulty and,

in some cases, impossibility of exposing the splanchnic nerves after incision of the abdominal wall. The method is not advantageous when lesions of the stomach, liver, and gallbladder prevent exposure of the lesser omentum. The stomach, liver and pancreas may be adherent. Exposure is very difficult in patients with tense abdominal walls. In thin, relaxed patients it is possible to slip the fingers into the abdominal cavity and open up a pathway for the needle, whereas in others a general anesthetic is actually necessary for the intra-abdominal manipulation.

Certain surgeons, however, find the Braun method superior to the Kappis. Buhre [17] recalls that not all the experiences with the Kappis method are favorable. He believes that in the latter method the needle is usually not carried forward far enough to the anterior surface of the vertebra, and that sometimes the injection is made close to the intervertebral foramen. He prefers the anterior method because the injection is made under the guidance of the eye. Many men favoring the anterior method do not perform physiologic block of the splanchnic nerves, but merely infiltrate peritoneal ligaments locally. Infiltration of the neck of the gallbladder and hepatico-duodenal ligament should not be regarded as splanchnic nerve block, since the splanchnics terminate anatomically in the semilunar ganglion.

Many favorable comments on the quality of anesthesia and operative condition that it produces have been made, all, however, by men in foreign clinics.[18] Hoffman [19] considers the method a great advance in abdominal surgery. Quarella [20] asserts that there is no abdominal rigidity or shrinking away from the knife; the patient's color and pulse keep good and breathing is tranquil. Billet and Laborde [21] believe that the method is efficacious, easily applied, without risk, and permits the most delicate operations in the upper abdomen. Buhre has observed no "by-effects" or after-disturbances. Labat maintains that the method

17. Buhre, G.: Die Unterbrechung der Nn. splanchnici bei Bauchoperationen, Deutsch. med. Wchnschr. **46**:93-94 (Jan. 22) 1920; Weitere Erfahrungen mit der Splanchnicusunterbrechung nach Braun, Centralbl. f. Chir. **48**:818-821 (June 11) 1921.

18. Perrier, C.: L'anesthesie locale en chirurgie abdominale (Anesthesie des nerfs splanchniques), Rev. méd. de la Suisse Rom. **41**:355-362 (June) 1921. Roussiel, M.: Etude critique des proceeds d'anesthesie utilises en chirurgie gastrique, Jour. de chir. **17**:449-460, 1921; Anesthesie des nerfs splanchniques et des plexus mesentericus sup. et inf, Presse méd. **31**:4-6 (Jan. 3) 1923. Schaps, T.: Beobachtungen an 600 in Injektionsanästhesie vorgenommenen Operationen, München. med. Wchnschr. **69**:854-856 (June 9) 1922. Sourdat, P.: L'anesthesie regionale en chirurgie gastrique, Presse méd. **27**:193-194 (April 10) 1919.

19. Hoffman, A.: Splanchnicusanästhesie in der Bauchchirurgie, Zentralbl. f. Chir. **47**:53-54 (Jan. 17) 1920.

20. Quarella: Sulla considetta anestesia degli splanchici, Policlinico, Rome, **29**:1402-1403, 1922.

21. Billet, H., and Laborde, E.: Anesthesia régionale. Note au sujet de l'anesthesie dite des splanchniques, Presse méd. **29**:261-262 (April) 1921.

is easy, simple, and safe, and should be attempted as often as possible. Finsterer refuses to employ general anesthesia in upper abdominal surgery, and when patients decline to be operated on under local anesthesia, directs them to other surgeons. Many other similar comments could be cited.[22]

FORTY-TWO CASES OF SPLANCHNIC NERVE BLOCK

In view of such glowing reports from reputable sources, it is only logical that the method should be given a trial. The dangers of a long ether anesthesia in upper abdominal surgery are largely the post-anesthetic effects, all of which are claimed to be avoided by the splanchnic method. In the Mayo Clinic, the posterior route of approach was introduced by Labat in November, 1920. Since then, operation has been attempted by this method in only forty-two cases. So many difficulties have attended the performance of these operations, necessitating recourse to a general anesthetic, that an analysis of the series is deemed advisable.

Anesthesia of the abdominal wall was established in all cases by field block after the method of Braun. The patient is placed in the dorso-horizontal position and wheals are raised along the costal and lateral margins of the recti muscles. With a larger needle, the anesthetized skin is punctured at these points and the needle advanced in the superficial fascia, inclined toward the abdominal aponeurosis. The aponeurosis at the margin of the rectus is just perforated, and about 2 c.c. of solution is injected at this point. The needle is then withdrawn until its point lies in subcutaneous tissue, and reintroduced at intervals of about 1 cm. upward and downward, and solution distributed below the aponeurosis in the same straight line. Deep injections are similarly made along the costal margin, and the wheals joined together by superficial fanwise injections, forming a wall of anesthetic fluid projected in the planes shown in Figure 3 and extending from skin to peritoneum. The entire area of abdominal wall within these planes is then completely anesthetized. One of the chief advantages of this method is the complete relaxation of the recti muscles, which greatly facilitates retraction. There is complete loss of sensation, and the abdominal walls can always be incised painlessly.

In this series of cases, the abdominal wall field block was performed first, thus allowing time for the diffusion of the solution from the dif-

22. Billet, H., and Maisonnet, J.: L'anesthesie des splanchniques dans la néphrectomie, Bull. et mém. Soc. de chir. de Paris **49**:157-167, 1923. Carnot and Cambessedes, P.: L'anesthésie des neufs dorsaux et splanchniques dans les crises gastriques du tabes, Paris méd. **37**:349-351, 1920. Graef, W.: Ueber Splanchnicusanästhesie, München. med. Wchnschr. **68**:142 (Feb. 4) 1921. König, F.: Erfahrungen an 600 Fallen von Kokal- und Leitungsanästhesie, Deutsch. Ztschr. f. Chir. **172**:287-296, 1922. Laborde, P.: Anesthésie splanchnique, Paris méd. **37**:348-349, 1920.

ferent injections to form a complete wall. The patients were next turned first on one side, then on the other, for the splanchnic nerve block by the posterior route, as described. The local anesthetic technic was executed preliminary to the operation, at least fifteen minutes elapsing in all cases between the anesthetization and the beginning of the operation. Experiments on cadavers show that when methylene blue is injected, about fifteen minutes are required for diffusion of the solution through the paravertebral cellular tissue in the region of the splanchnic nerves.

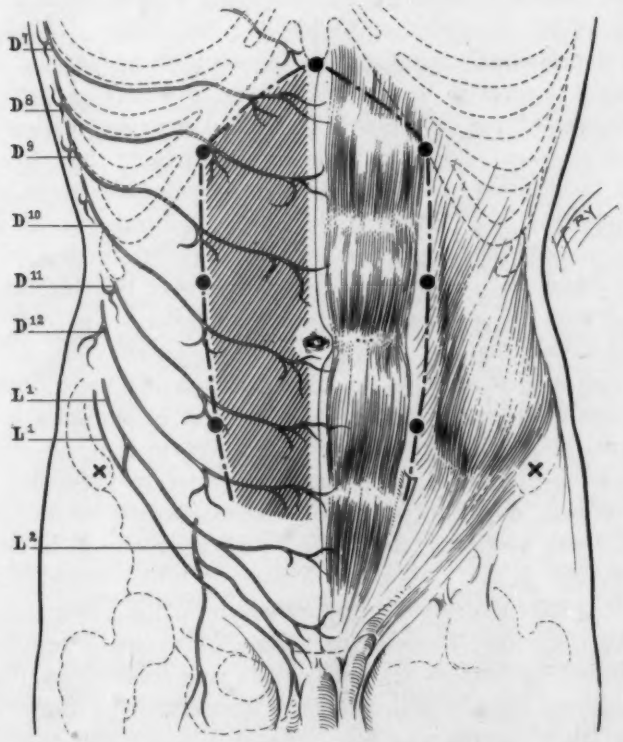

Fig. 3.—Field block of the abdominal wall; the dots mark the sites of puncture along the lateral margins of the rectus sheath, from which walls of anesthetic solution are projected (after Labat).

Users of this method usually base their percentage of success on the necessity for the employment of a general anesthetic during the operation. By this criterion, Naegeli [23] had 23 per cent. of failures in an

23. Naegeli, T.: Splanchnikusanästhesie bei Bauchoperationen, Ztschr. f. Chir. **45**:1375, 1919; Splanchnikusanas thesie bei chirurgischen Eingriffen und schmerzhaften Affektionen in der Bauchhöhle, Ztschr. f. Chir. **46**:749-751, 1919; Splanchnicusanästhesie bei Bauchoperationen, Deutsch. Ztschr. f. Chir. **153**:252-262, 1920.

early series of cases. Preiss [24] records unsatisfactory anesthesia in 12 per cent. of 192 cases. Gutierrez [25] admits 13 per cent., while Carulla [26] is satisfied with his results. Table 1 shows that ether was given in sixteen of forty-two cases (38 per cent.), probably a higher percentage than in any other series available (Table 1).

Whether or not a general anesthetic was given, however, does not determine the success of local anesthesia. A more reliable estimate would be based on whether the patient suffered any pain, and whether there was relaxation of both tissues and mind. The operation attempted under local anesthesia, with the patient crying with pain and strapped on the table, is but a reversion to pre-anesthetic days. Based on the patient's impressions, therefore, the percentage of success would be much lower. Pain may be of little concern to many patients who evidently feel very little, or are able to control their expressions of pain. With such a patient, the surgeon is apt to attribute the success of the anesthesia to block of the splanchnic nerves, whereas simple infiltration of the abdominal wall alone could have produced exactly the same quality of anesthesia. Other patients are hyperesthetic, either being extremely susceptible, or having little control over their feelings. With such a patient, the surgeon with overconfidence in splanchnic nerve block may decide that the patient suffers no actual pain, and proceed with the operation in spite of the patient's most vehement protestations. Such an operation would appear as a success in statistics because no general anesthetic was administered, although to the patient it would constitute a most harrowing experience. We freely admit that pain and discomfort were experienced at some time in most of the forty-two cases, and that "abdominal silence" was never produced as with spinal anesthesia.

In order better to control the apprehension natural in a patient about to undergo operation, a preliminary dose of morphin combined with scopolamin was given. A tranquil or inactive state of mind was thus produced, protecting the patient against himself. The size of the dose was never large, usually one dose only of 1/6 grain (0.0108 gm.) of morphin and 1/200 grain (0.000325 gm.) of scopolamin. This is in marked contrast to the deep preliminary medication employed by most Europeans. An analysis of the literature reveals the fact that barbital

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24. Preiss, G. A.: Ausschaltung der Bauchhöhlensensibilität duerch Blockierung der Nervi splanchnici und der Rami communicantes des lumbalen Grenzstranges, Deutsch. Ztschr. f. Chir. **159**:59-101, 1920. Preiss, G. A., and Ritter, A.: Zur Anwendung der Splanchnikusanästhesie, Zentralbl. f. Chir. **46**: 1025-1029, 1919; Blocking the Splanchnic Nerves, J. Nerv. & Ment. Dis. **53**:361-366 (May) 1921.

25. Gutiérrez: Anesthesia espancnica, Semana méd. **2**:1-17 (July 6) 1922.

26. Carulla Riera, V.: La anesthesia simpática en cirurgia gástrica; Observaciones personales, Rev. españ. de med. y chir. **4**:272-277, 1921.

or bromids were usually given the night before an operation, and the morphin and scopolamin repeated sufficiently to produce a "twilight sleep." Often the patients could not be aroused, so that splanchnic nerve block was superfluous. The term splanchnic anesthesia applied to such cases is obviously a misnomer, as the anesthesia more properly consists of general narcosis by hypodermic injections. Most authorities stress the importance of deep preliminary narcosis for the success of the splanchnic method.

The quantity of solution employed for splanchnic nerve block has, as a rule, been less than that generally employed abroad. Experience on the cadaver convinces one that 30 c.c. usually diffuses to the splanchnic nerves in from fifteen to twenty minutes. From 40 to 50 c.c. of a 1 per cent. solution is more often employed by Europeans, and occasionally from 25 to 30 c.c. of a 2 per cent. solution on each side. There is excellent authority for the statement that 0.5 gm. of procain constitutes a safe maximal dose, and that any larger amount may produce toxic manifestations. Twice the amount of the safe dose is, therefore, employed for splanchnic nerves alone. Moreover, it is injected in a location from which absorption takes place very rapidly. A part of the success of splanchnic nerve block, especially in patients of low resistance, may therefore be ascribed to toxic depression due to the absorption of procain.

SENSIBILITY OF THE ABDOMINAL WALLS AND VISCERA

A better explanation of the unsatisfactory operative condition produced for both patient and surgeon in this series of cases may be obtained by a consideration of the distribution of the pain-conducting fibers of the operative area. In the abdominal wall, the skin is undoubtedly the most sensitive layer, and in acute abdominal conditions it may be even more tender than it is normally. Superficial fascia is not sensitive, although it contains all the nerves destined for the skin. Patients rarely complain of any pain while the superficial fascia is being injected. Deep fascia is more sensitive, probably because of its denser structure. In the lateral regions of the abdominal wall, the deep fascia is probably somewhat less sensitive than in the region of the recti muscles, but piercing of the deep fascia is always sensed by the patient, and serves as a guide for injection. The parietal peritoneum is also very sensitive to pain, as is shown by applying stimuli which produce pain in other tissues.

The parietal peritoneum derives its pain-conducting nerves from the seven lower intercostal, the lumbar and upper sacral nerves, and the entire diaphragm, except the rim from the phrenic nerves. The rim is supplied by the seven lower intercostals. These facts have been demon-

TABLE 1.—*Operations and Results*

Case	Diagnosis	Operation	Field Block		Right Splanchnic		Left Splanchnic		Quality of Anesthesia	Remarks
			C.c.	Per Cent.	C.c.	Per Cent.	C.c.	Per Cent.		
1	Chronic appendicitis	Appendectomy	150	0.5	50	1.0	..	...	Sufficient	Dismissed in 10 days
2	Cancer of the stomach	Partial gastrectomy; posterior end-to-side anastomosis, Polya type	150	0.5	30	1.0	..	...	Sufficient	Dismissed in 23 days
3	Chronic duodenal ulcer	Posterior gastro-enterostomy	150	0.5	50	0.5	50	0.5	Sufficient	Dismissed in 10 days
4	Undetermined	Exploration; appendectomy	150	0.5	50	1.0	50	1.0	Ether required	Dismissed in 11 days
5	Chronic cholecystitis	Cholecystectomy	100	0.5	50	1.0	..	...	Sufficient	Dismissed in 20 days
6	Cancer of the stomach	Partial gastrectomy; anterior end-to-side anastomosis, Pólya type	150	0.5	30	1.0	30	1.0	Sufficient	Dismissed in 13 days
7	Chronic duodenal ulcer	Excision of ulcer; posterior gastro-enterostomy	100	0.5	30	1.0	30	1.0	Ether required	Dismissed in 12 days
8	Cancer of the stomach	Exploration; inoperable	200	0.5	40	1.0	30	0.5	Ether required	Dismissed in 8 days
9	Cholecystitis with stones	Cholecystectomy	150	0.5	30	0.75	30	0.75	Ether required	Dismissed in 19 days
10	Cancer of stomach with obstruction	Anterior gastro-enterostomy	100	0.5	30	1.0	30	1.0	Sufficient	Dismissed in 8 days
11	Chronic obstructing duodenal ulcer	Posterior gastro-enterostomy	100	0.5	30	1.0	30	1.0	Ether required	Dismissed in 25 days
12	Chronic cholecystitis with stones	Cholecystectomy	160	0.5	35	1.0	35	1.0	Ether required	Dismissed in 13 days
13	Chronic ulcer of duodenum with obstruction	Posterior gastro-enterostomy	125	0.5	40	1.0	35	1.0	Sufficient	Dismissed in 15 days
14	Cancer of stomach with obstruction	Second stage resection of stomach	100	0.5	30	1.0	30	1.0	Sufficient	Dismissed in 14 days
15	Chronic cholecystitis and appendicitis	Cholecystectomy and appendectomy	150	0.5	40	1.0	..	...	Ether required	Dismissed in 13 days
16	Cholecystitis with stones	Cholecystectomy and choledochostomy	125	0.5	50	0.5	50	0.5	Sufficient	Dismissed in 18 days
17	Chronic duodenal ulcer with retention	Posterior gastro-enterostomy	150	0.5	50	0.75	..	...	Ether required	Dismissed in 11 days
18	Perforating gastric ulcer with retention	Partial gastrectomy; anterior end-to-side anastomosis, Pólya type	150	0.5	50	1.0	40	1.0	Nitrous oxid-oxygen required	Dismissed in 15 days
19	Subacute cholecystitis with stones	Cholecystectomy and appendectomy	100	0.5	50	1.0	..	...	Sufficient	Dismissed in 13 days
20	Cancer of stomach with obstruction	Resection of the stomach; anterior end-to-side anastomosis, Pólya type; entero-anastomosis	100	0.5	35	1.0	35	1.0	Ether required	Dismissed in 9 days

21	Duodenal ulcer	Posterior gastro-enterostomy	100	0.5	40	0.5	40	0.5	Sufficient	Dismissed in 15 days
22	Multiple duodenal ulcers with retention	Posterior gastro-enterostomy	130	0.5	30	1.0	30	1.0	Ether required	Dismissed in 14 days
23	Acute duodenal obstruction with tetany	Posterior gastro-enterostomy (emergency)	150	0.5	30	0.5	30	0.5	Sufficient*	Died 3 days after operation
24	Duodenal ulcer with hemorrhage	Cautery of ulcer; posterior gastro-enterostomy	150	0.5	40	1.0	40	1.0	Ether required	Dismissed in 9 days
25	Cancer of stomach with obstruction	Partial gastrectomy; antecolic end-to-side anastomosis, Pólya type	150	0.5	35	1.0	35	1.0	Sufficient	Dismissed in 9 days
26	Duodenal ulcer with obstruction	Posterior gastro-enterostomy; appendectomy	150	0.5	40	1.0	40	1.0	Sufficient	Dismissed in 10 days
27	Cancer of stomach with obstruction	Posterior gastro-enterostomy	125	0.5	40	0.5	40	0.5	Sufficient	Dismissed in 13 days
28	Inoperable cancer of the stomach	Exploration	100	0.5	50	1.0	50	1.0	Ether required	Dismissed in 8 days
29	Inoperable cancer of the stomach with retention	Anterior gastro-enterostomy	150	0.5	30	1.0	30	1.0	Sufficient	Dismissed in 8 days
30	Inoperable cancer of the stomach with obstruction	Anterior gastro-enterostomy	110	0.5	30	0.75	30	0.75	Sufficient	Dismissed in 12 days
31	Inoperable cancer of the stomach	Exploration	120	0.5	35	1.0	35	1.0	Ether required	Dismissed in 8 days
32	Cancer of the stomach	Partial gastrectomy; antecolic end-to-side anastomosis, Pólya type	130	0.5	40	0.5	40	0.5	Ether required	Dismissed in 8 days
33	Ulcer of the duodenum with retention	Posterior gastro-enterostomy	150	0.5	40	1.0	40	1.0	Sufficient	Dismissed in 12 days
34	Duodenal ulcer with hemorrhage	Excision of gastric and duodenal ulcers; pyloroplasty	110	0.5	25	1.0	25	1.0	Sufficient	Dismissed in 18 days
35	Cancer of stomach with obstruction	Posterior gastro-enterostomy	150	0.5	40	0.5	40	0.5	Ether required	Died 7 days after operation†
36	Perforating gastric ulcer	Sleeve resection; end-to-side anastomosis	130	0.5	35	1.0	35	1.0	Sufficient	Died 14 days after operation‡
37	Cancer of stomach with retention	Exploration	150	0.5	40	1.0	40	1.0	Sufficient	Dismissed in 5 days
38	Cancer of the stomach	Partial gastrectomy; posterior Pólya operation	150	0.5	40	1.0	40	1.0	Sufficient	Dismissed in 16 days
39	Cancer of the stomach	Partial gastrectomy	165	0.5	40	1.0	40	1.0	Sufficient	Dismissed in 19 days
40	Duodenal ulcer with retention	Posterior gastro-enterostomy	150	0.5	50	0.5	50	0.5	Sufficient	Dismissed in 23 days
41	Gastric ulcer	Cautery excision and posterior gastro-enterostomy	160	0.5	40	1.0	40	1.0	Ether required	Dismissed in 20 days
42	Duodenal ulcer with hemorrhage	Cautery excision of ulcer; posterior gastro-enterostomy; appendectomy	150	0.5	40	1.0	40	1.0	Ether required	Dismissed in 14 days

* Patient unconscious at end of operation. Necropsy findings: Acute diffuse nephritis; bilateral bronchopneumonia; primary obstructing cancer of the duodenum.
† Necropsy findings: Coronary thrombosis; pulmonary thrombosis; advanced chronic diffuse nephritis, beginning bronchopneumonia.
‡ Necropsy: Acute generalized peritonitis and hypostatic bronchopneumonia.

strated by anatomic dissection, and were first verified by Ramström.[27] He also traced spinal filaments into the roots of the mesenteries, which has been verified by the writer.

The question of the sensory nerve supply of the abdominal viscera has been a subject of dispute between men basing their opinions on findings at operations on human beings, and those who have arrived at conclusions purely from animal experimentation.

This subject was first given the attention it merited by Lennander.[28] By a careful and exhaustive series of observations on patients operated on under abdominal wall infiltration with cocain solutions, he established the fact that the abdominal viscera possessed no sense of pain, at least that cutting, crushing, and cauterizing did not give rise to pain. He found that the mesentery and omentum were also insensitive to these stimulae, but the parietal peritoneum was very sensitive, and its sensibility greatly increased with even slight inflammation. Similar observations had been made by Mackenzie[29] during operations, and many of his patients had not had even a local anesthetic. These facts have been confirmed repeatedly the world over by surgeons operating under local anesthesia, the less toxic procain having been substituted for the cocain solutions. These conditions hold true with the viscera, in their normal anatomic relations bathed in peritoneal fluid and outside of the abdominal cavity. Indeed, conditions are the same with the abdominal cavity closed, as has been repeatedly determined by exploration of the abdominal contents with the endoscope. On the basis of these facts, Lennander formulated the theory that all pain in visceral disease results from inflammation of, or traction on, the parietal peritoneum. These views have been confirmed and accepted by most surgeons, although they do not satisfactorily explain several features regarding the pain in certain pathologic conditions.[30]

Animal experimenters have a tendency to oppose Lennander's views. Kast and Meltzer,[31] in many experiments, mostly on dogs, offered ques-

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27. Ramström: quoted by Lennander (Footnote 28).

28. Lennander, K. G.: Abdominal Pain (Especially Pain in Connection with Ileus), J. A. M. A. **49**:836-840, 1907. Local Anesthesia, Keen's Surgery, Philadelphia, Saunders **5**:1046-1049, 1911.

29. Mackenzie, quoted by Hurst (Footnote 37).

30. Mitchell, J. F.: The Sensibility of the Peritoneum and Abdominal Viscera, J. A. M. A. **57**:709-712, 1911. Nyström, G.: Kritische Bemerkungen zureingen neueren Arbeiten über die Sensibilität der Bauchorgane, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **21**:125-142, 1910.

31. Kast, L., and Meltzer, S. J.: Die Sensibilität der Bauchorgane, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **19**:586-616, 1909.

tionable proof of the error of Lennander's views in almost every point. Their criticism of the systemic effect of cocain in Lennander's operations should now be rejected because of repeated observations of the same effects with procain infiltration, a drug clinically one-tenth as toxic as cocain, and occasional observations on the abdominal viscera without any anesthesia. The presence of pain was tested by watching the reaction of animals to mechanical and electric stimuli. But such a demonstration on dumb animals merely indicates the passage of an afferent impulse from the viscus; it does not prove it to be pain. Painless visceral afferent impulses, no doubt, play a part in the forced or involuntary movements of all animals. No conclusions concerning visceral pain in man deduced solely from animal experimentation are therefore justified.

After having performed many abdominal operations with a simple infiltration of the abdominal wall, Kappis very strangely resorted to experimentation on dogs to solve the nervous pathways of visceral pain in man. He assumed the existence of inherent visceral pain which has never been proved, and attempted to determine the nervous pathways over which these impressions travel. After sectioning the splanchnic nerves, and the cord at different heights, he tested the sensibility of the abdominal contents by various stimuli. Sectioning of the splanchnics, he believed, anesthetized the stomach, spleen, and upper part of the small intestine. Section of the cord between the fifth and sixth dorsal vertebrae abolished all abdominal sensation. Section of the cord between the seventh and eighth dorsal vertebrae abolished visceral pain in the lower abdomen up to the middle of the small intestine, but the stomach, spleen, and upper part of the small intestine were found to be sensitive. Between the thirteenth dorsal and first lumbar vertebrae, sensibility stopped at the cecum. Kappis concluded, therefore, that below the cecum all organs were supplied by the lumbar and sacral nerves. Labat claims to have confirmed clinically that blocking of the last three lumbar and the sacral nerves completely anesthetizes the pelvis and its contents, yet he admits that abdominal organs are not sensitive to pain; that they may be incised, clamped or cauterized without the patient's knowledge.

Kappis' conclusions as regards visceral pain in man are not tenable since they do not agree with the immense wealth of clinical observations made by surgeons operating under local anesthesia. The value of animal experimentation in this subject is very questionable. Movements of the head, extremities and body, and whining, following stimulation, are not proof that the animal suffers visceral pain. Such motor responses may be the result of pain, or arise quite independently of it. They may be simple reflex effects, not accompanied by pain. Carlson and Luck-

hart [32] have shown that these skeletal reflexes may be produced by stimulating the gastro-intestinal tract both in decerebrated and in purely spinal preparations, and Carlson has shown that afferent impulses from the stomach may travel over the vagus nerve. Gianolla,[33] a Belgian surgeon, who resected the gastric branches of the vagus nerve in eight patients, confirms Latarjet's and Wertheimer's [34] favorable opinion on the results of the neurectomy in painful gastric ulcers.

Kast and Meltzer criticize surgical observations on men, and maintain that surgery provides no proof that the viscera of normal man under normal conditions can feel no pain; but that this evidence is the most important of any cannot be denied. It may, of course, be possible that a stimulus adequate to produce visceral pain is not applied in cutting, crushing, or cauterizing; yet, these same means of irritation were used on animals, and an attempt made to give them more weight than the statements of conscious patients. Animal experimentation only emphasizes the fact that it is very difficult to interpret correctly animals' impressions, as borne out by the fact that Müller [35] repeated the experiments of Kast and Meltzer, obtaining exactly opposite results, while Hotz [36] reports that manipulations of even strangulated or peritonitic loops of intestine do not cause any expression of pain, and that manipulation of the mesentery causes pain only when traction is made. Although animal experimentation is very valuable in settling many doubtful points, the data obtained concerning visceral pain is questionable. Animals may either suffer patiently or wiggle, tug and whine because of the restraint, and resist handling much the same as they would react to pain inflicted in an experiment. In fact, such actions are more likely to be manifested while they are being handled. Animals cannot settle the controversy as applied to human patients, since no results with the former can outweigh the accumulation of surgical evidence. The patient must be the judge, and interpret his own impressions in all cases.

Hurst [37] criticizes the conclusions of Lennander and Mackenzie in that they ignored the fact that a nerve ending may be sensitive to only one form of stimulation, its adequate stimulus. Thus, the adequate

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32. Carlson, A. J., and Luckhart, A. B.: Studies on the Visceral Sensory Nervous System. VII. Am. J. Physiol. **55**:366-384 (April) 1921.

33. Gianolla: Denervation of the Stomach, Arch. méd. belges **70**:618, 1923; abstr. J. A. M. A. **81**:1989 (Dec. 8) 1923.

34. Latarjet and Wertheimer, quoted by Gianolla (Footnote 33).

35. Müller, L. R.: Ueber die Empfidungen in unseren inneren Organen, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **18**:600-641, 1908.

36. Hotz, G.: Beitrage zur Pathologie der Darmbewegungen, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **20**:257-318, 1909.

37. Hurst, A. F.: The Sensibility of the Alimentary Canal, London, Oxford Univ. Press, 1911, pp. 43-75.

stimulus for the eye is light; for the ear, sound, and so forth, although in certain cases there may be several varieties of adequate stimuli. Surgeons have merely shown that the viscera are insensitive to the stimulus which they employed, and if there were an adequate stimulus it might cause the viscera to be sensitive to pain. From a consideration of the common causes of visceral pain, one might expect tension on the fibers of the muscular coat to be the adequate stimulus. Hurst thus maintains that a certain degree of distention leads to the sensation of fulness, if the internal pressure is slowly raised, whereas if rapidly produced it leads to pain. He admits, however, that disease of the alimentary tract is very often accompanied by pain due to the extension of the disease to the parietal peritoneum, to dragging on peritoneal attachments, and to reference to peripheral structures. His theory is of no value so far as surgical anesthesia of the abdomen is concerned, because surgical manipulations do not constitute an adequate stimulus to visceral pain.

FAVORABLE CONDITIONS

A factor of great importance in any series of operations under local anesthesia is whether the patients are naturally good subjects for the procedure. The surgeon experienced in local anesthetic work can judge beforehand what demands he can make in operations on conscious patients. The expression and degree of pain vary greatly with the individual, and are influenced by many factors such as character, breeding, intelligence, nationality, age, sex, and general physical condition. An analysis of these factors (Table 2) indicates that most of these patients would have been favorable subjects for local anesthesia. Their average age was past middle life. They were largely of the farmer-labor class, representing a type of patient usually quite cooperative and tolerant to a certain degree of pain. Their poor general condition, in many cases, made them more or less indifferent to their surroundings, and there were no pronounced neurotics in the entire series.

LOCATION OF PAIN

Laparotomy was, in all cases, performed with little or no pain. The performing of intra-abdominal operations painlessly was found to depend on many other factors. The patient's first manifestation of pain usually appeared during exploration. In most of these cases, a complete revision of the entire abdominal contents was indicated, and performed in the same manner as in patients under general narcosis. The pain, no doubt, was due to the fact that the parietal peritoneum and bases of the mesenteries were not anesthetized, since the pain was usually of the same intensity and at the same stage as in a series of abdominal cases in which the splanchnics were not blocked. Most advo-

cates of local anesthesia deny the patients the advantage of a thorough abdominal exploration, and some depend entirely on visual rather than tactile impressions, which are good so far as they go, but are not complete. Exploration is not satisfactory without digital palpation, and when deep structures are examined thus, traction on the mesenteries, parietal peritoneum or adhesions results. Under such conditions, the patient cannot cooperate well. The effect of traction was again seen in bringing the stomach out of the wound for gastro-enterostomy, and in exposing the gallbladder and appendix. Pain was usually experienced when saline packs were placed between viscera and parietal peritoneum, and when they were removed; but placing the compresses between the viscera was not painful when the parietal peritoneum was carefully avoided, and no traction made on the mesenteries. Indeed, the entire reaction of the patients to intra-abdominal painful stimuli indicated it to be because of the irritation of spinal nerves, and not of the sympathetics, arising either from parietal peritoneum or the bases of the mesenteries.

OPERATIONS WITHOUT INTRA-ABDOMINAL ANESTHESIA

Valuable information was obtained by comparing the results in this series of 42 cases with those in a series of 122 cases of upper abdominal operations with local anesthesia of the abdominal wall, and no intra-abdominal anesthesia. The ages, types of operation, general resistance and temperament of the patients, were similar in the two series. A short general anesthesia was necessary for intra-abdominal manipulation in only 26 per cent. of all cases, whereas in the series with splanchnics blocked, 38 per cent. required the addition of a general anesthetic. It was repeatedly observed that the intolerable pain occurred at about the same stage in both series of cases, and was always traceable to a stimulation of spinal nerve filaments to the parietal peritoneum and bases of the mesenteries. One is therefore forced to conclude that block of the splanchnic nerves in no case gives a surgical anesthesia of the abdominal cavity and contents, and that the quality of anesthesia inside the abdomen is about the same, whether or not the splanchnics are blocked. Anesthesia was more likely to be incomplete when the diagnosis was obscure, and when acute inflammation or extensive adhesions were present. The obese patients, those with tense, rigid abdominal walls and acute costal angle, were more difficult to handle, whereas the thin patients with relaxed abdominal walls, flat chests anteroposteriorly with wide costal angles, long mesenteries, and with a cooperative mental attitude tolerated extensive operations without complaint. At present, therefore, success in abdominal operations under local anesthesia still depends on the proper selection of cases, deep preliminary hypodermic narcosis, and on gentle management after incision. Block of the splanchnic nerves by the Kappis method we regard as

TABLE 2.—*Analysis of Factors*

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Case	Sex	Age	Weight, Pounds	Loss of Weight, Pounds	Occupation	Risk*	Factors Influencing Risk
1	M	49	155	..	Laborer	2	Old alcoholic
2	M	68	108	17	Farmer	3	General weakness; systolic blood pressure 90, diastolic 60; hemoglobin 50 per cent.; urine: albumin 1, pus 1 and casts
3	M	45	114	28	Dry goods clerk	2	Chronic bronchitis; mild nontuberculous lung infection
4	M	49	230	..	Storekeeper	2	Obesity and chronic cough
5	F	54	125	5	Housewife	3	Cardiorenal disease; mitral regurgitation; albumin, pus and casts in urine
6	F	45	124	31	Farmer's wife	3	Cardiorenal disease; dyspnea; râles in chest; albumin and pus in urine; hemoglobin, 32 per cent.; erythrocytes, 3,023,000
7	M	54	195	..	Laborer	3	Myocardial degeneration; sinus tachycardia; emphysema
8	M	56	136	15	Farmer	4	Extreme weakness; poor general condition
9	M	54	133	18	Laborer	2	Aortic diastolic murmur; albumin, pus and casts in urine
10	M	52	137	38	Machinist	4	Poor general condition; anemia; systolic blood pressure 98, diastolic 65; hemoglobin, 55 per cent.; erythrocytes, 2,990,000
11	F	76	110	30	Farmer's wife	3+	Age and poor general condition
12	M	63	182	..	Farmer	2	Albumin and pus in the urine; renal function, 50 per cent.
13	M	33	118	28	Railroad worker	1	
14	M	70	154	50	Farmer	3	Age and general weakness
15	M	40	142	..	Physician	2	Chronic bronchitis; Bacillus coli infection of kidneys
16	F	76	108	15	Farmer's wife	3	Age, nephritis and hypertension; functional, 20 per cent.; blood urea, 50 mg.
17	M	64	125	10	Farmer	2	General condition poor
18	M	50	135	25	Farmer	2+	Poor general condition from marked obstruction; albumin and casts in urine
19	F	68	102	30	Farmer's wife	3+	Poor general condition; chronic cough; albumin, casts and pus in urine; renal function, 45 per cent.
20	M	65	135	40	Farmer	3	Poor general condition; hemoglobin, 45 per cent.
21	M	46	150	10	Boiler maker	1+	Quiescent pulmonary tuberculosis; arthritis
22	M	65	144	..	Physician	2+	Cardiorenal disease; systolic blood pressure 175, diastolic 95
23	M	61	134	50	Attorney	3+	Marked cachexia and weakness; albumin, pus and casts in urine; blood urea 180; systolic blood pressure 98, diastolic 80; gastric tetany
24	M	29	154	5	Harness maker	2	Secondary anemia; hemoglobin, 48 per cent.; systolic blood pressure 104, diastolic 64
25	M	72	123	35	Laborer	3	Hypertension with renal impairment
26	M	50	152	5	Coal miner	3	Cardiorenal impairment; active pulmonary tuberculosis and tuberculosis of the larynx
27	M	46	125	50	Farmer	3	Poor general condition, anemia and cachexia; albumin, pus and casts in urine; systolic blood pressure 100, diastolic 78
28	M	55	155	28	Farmer	3	Cachexia and poor general condition; dyspnea; albumin and casts in the urine
29	M	46	122	33	Farmer	3	General weakness; albumin and pus in the urine; hemoglobin, 60 per cent.; erythrocytes, 3,810,000; systolic blood pressure 110, diastolic 70
30	M	57	110	30	Farmer	3	General weakness; dyspnea and chronic cough; albumin, pus and casts in the urine; systolic blood pressure 100, diastolic 70
31	F	38	127	15	Druggist's wife	3	Cachexia and poor general condition; albumin and pus in the urine
32	F	52	131	30	Farmer's wife	3	Cachexia and general weakness; albumin and pus in the urine
33	M	59	165	..	Harness worker	3	Myocardial degeneration; tachycardia and arrhythmia
34	M	49	110	10	Leather worker	3	General weakness and anemia; hemoglobin, 32 per cent.; erythrocytes, 3,200,000; albumin, pus and casts in the urine; blood urea 45
35	M	76	200	..	Banker	3	Obesity; cardiorenal disease; hemoglobin, 30 per cent.; renal function, 35 per cent.; blood urea 45
36	M	58	120	25	Bricklayer	3	Diffuse tuberculosis; cavities in both apexes; asthenia
37	F	48	166	50	Teamster's wife	3	General weakness; hemoglobin, 44 per cent.; erythrocytes, 3,900,000
38	M	52	164	15	Farmer	3	Chronic myocarditis; cardiac hypertrophy with extra systole and auricular fibrillation; hemoglobin, 46 per cent.
39	M	54	145	30	Railroad watchman	4	Marked cachexia and general weakness; hemoglobin, 37 per cent.; erythrocytes, 2,580,000; albumin and pus in the urine
40	M	71	135	25	Farmer	3	Weakness and anemia; blood urea 62; kidney function, 45 per cent.; albumin and pus in the urine
41	M	52	187	30	Lumber inspector	2+	General condition
42	M	65	136	15	Storekeeper	3	General weakness; renal function, 40 per cent.; hemoglobin, 64 per cent.; erythrocytes, 3,750,000

* Surgical risks estimated on a scale of 4.

the feature least important for such success; indeed, its only possible value, besides that of producing toxic depression, is block of the spinal rami proceeding to the base of the mesogastrium at the site of injection, splanchnic nerve block being only incidental.

ACCIDENTS AND COMPLICATIONS

There are other disadvantages of the method besides its failure to give complete intra-abdominal anesthesia. Its safety has already been questioned.[38] The proposition is too freely accepted that local anesthesia is entirely safe.[38] So long as the technic consisted only of terminal infiltration and was restricted to minor surgery, it remained well within the limits of safety, but when the method came to be regarded as better for the weak patient, and the more complex nerve block and field block procedures with their many painful punctures and employment of larger amounts of more concentrated solutions followed,[39] reports came of toxic manifestations. Although procain is pharmacologically six or seven times less tonic than cocain, its toxicity must be kept in mind if large quantities are employed. When the statement is made that the effects of regional anesthesia are confined to a very small region of the body, leaving the vital functions intact, the effect of systematic absorption is disregarded. A drug hypodermically administered exerts its influence quite promptly, and in local anesthesia the entire amount is given in this manner. To insure the maximal amount of safety in cases of poor surgical risk, simple infiltration methods, rather than the most complex and difficult regional methods, should be employed. The problem of anesthesia for poor surgical risks seems to be better solved by local infiltration, or field block for laparotomies, supplemented by a short inhalation narcosis, preferably ethylene-oxygen, for intra-abdominal work if needed.

Under splanchnic anesthesia functional changes are often observed, from which patients usually recover, and they may have no significance.[40] A fall in blood pressure is usual, often 30 to 50 mm. of mercury, and sometimes more.[41]. Pallor is quite common, and sometimes there are nausea and vomiting. Cases of epileptiform seizures and

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38. Denk, W.: Erfahrungen mit der Kappischen Splanchnikusanästhesie, Wien. klin. Wchnschr. **40**:909, 1919; Die Abgrenzung der allgemeinen und der örtlichen Betäubung, Arch. f. klin. Chir. **116**:332-343 (July 30) 1921.

39. Wiedkopf, O.: Die Neben- und Nachwirkungen der örtlichen Betäubung, Deutsch. Ztschr. f. Chir. **167**:392-421, 1921. Wiemann, O.: Klinische Untersuchungen über das Verhalten von Blutdruck und Puls Während und nach Novokain-Suprarenin-Anästhesierung, Deutsch. Ztschr. f. Chir. **170**:150-181, 1922.

40. Bouma, U. G.: Zur Frage der Blutdrucksenkung bei der Splanchnicusunterbrechung, Zentralbl. f. Chir. **48**:1236-1239 (Aug. 27) 1921.

41. Schmidt, T.: Verhalten von Blutdruck und Puls bei Splanchnickusanästhesie, Med. Klinik **19**:465-466 (April 8) 1923.

collapse have been reported. Drüner [42] regards blocking of the splanchnic nerves as a dangerous procedure. After an experience with 198 cases, Kutscha-Lissberg [43] concludes that splanchnic anesthesia appears to be more dangerous than any other local method because of the rapid absorption in this location resulting in toxic symptoms and reflex collapse, as well as delayed acute gastric and intestinal disturbances. Hustink [44] has collected 1,375 cases in which operation was performed by this method. There were four deaths due to the anesthesia alone, a mortality higher than that for spinal anesthesia. It thus appears that splanchnic anesthesia, like spinal anesthesia, will never be generally used, since the quality of the anesthetization produced by the splanchnic method is far inferior to that produced by spinal anesthesia. For this reason, enthusiastic reports published on the basis of a few small series of cases of splanchnic block will usually be discounted by operators experienced in abdominal surgery under local anesthesia.

CONCLUSIONS

1. Abdominal viscera are insensitive to pain so far as the cutting, crushing, or cauterizing of an operation is an inadequate stimulus for the production of such pain. The breaking of conductivity in the splanchnic nerves for the relief of visceral pain in abdominal operations is, therefore, not in accordance with sound principles of anatomy and physiology.

2. The pain experienced by the patient in an abdominal operation under local anesthesia is caused by the stimulation of spinal and not sympathetic nerve filaments, since it arises as the result of either traction on mesenteries or direct irritation of parietal peritoneum. Paravertebral block of the fifth dorsal to third lumbar nerves for intra-abdominal anesthesia is anatomically and physiologically correct, but entirely impractical.

3. Clinical experience with splanchnic anesthesia proves it to be inefficient, since, by its use, a complete surgical anesthesia of the abdominal cavity is not produced. It is the least important of all the factors concerned in the success of an abdominal operation under local anesthesia.

4. Besides the production of an inadequate intra-abdominal anesthesia, splanchnic nerve block is not free from danger, a fact acknowledged by most users of the method. Four deaths in a collected series of 1,375 operations is a higher mortality than that recorded for spinal anesthesia.

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42. Drüner, L.: Ist die Leitungsanästhesie gefährlich? Deutsch. med. Wchnschr. **42**:957-958 (Aug. 18) 1921.

43. Kutscha-Lissberg, E.: Erfahrungen mit der Splanchnikusanästhesie, Wien. klin. Wchnschr. **36**:216-220 (March 22) 1923.

44. Hustinx: Splanchnic Anesthesia as Tested in 119 Cases, Nederl. Tijdschr. v. Geneesk. Haarlem **2**:558 (Aug. 11) 1923; abstr. International Survey of Surg. **6**:540-541, 1923.

MECKEL'S DIVERTICULUM

A REPORT OF TWELVE CASES, INCLUDING ONE TUMOR

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NEW YORK

The human body is an attic of antiquities, some of them more and some less recently discarded. The vermiform appendix has been relegated to the attic within comparatively recent times, while Meckel's diverticulum belongs to the remote antiquity of the race and to the earliest days of the individual. These discarded structures are a constant menace, and may start a conflagration in the structure at any moment. The fact that the vitellin duct, of which Meckel's diverticulum is a remnant, has but a slight and early function in the development of the human fetus is no doubt responsible for its infrequent persistence as compared with that of the veriform appendix, which is always present. Articles on the subject of Meckel's diverticulum usually state that it is present in two per cent. of individuals, one writer seeming to quote the statement from others. It seems to me that two per cent. is an overestimate. Dr. Knox, of St. Luke's Hospital, records three chance findings of diverticula in more than 500 necropsies (Figs. 1 and 2). Balfour [1] reports fifteen diverticula in 10,600 abdominal operations at the Mayo clinic. In only five of these was the diverticulum the cause of the pathologic condition. It is not unlikely that a good many are overlooked at operation, although in pelvic operations in women, the small intestine is nearly always brought to view, and one would expect the number overlooked to be rather small in this class of cases. Only one of the twelve cases reported here was an accidental finding in a pelvic operation. It has been a rather curious observation that males are more frequently affected than females. Of the twelve cases reported here, eight patients were males, and four were females. The disproportion in other series has been even greater. The age at which a diverticulum may cause clinical symptoms has not been much stressed by writers although, in the present series and in others series of cases, young adults and children have predominated in the clinical cases. In the twelve cases briefly recorded, three of the patients have been without symptoms, and in the nine others, the diverticulum has been an important part of the clinical entity.

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1. Balfour, D. C.: Journal of Minnesota State Medical Association **31**:110, 1911.

REPORT OF CASES

CASE 1.—A. N., a woman, aged 37, was admitted Sept. 20, 1913, to St. Luke's Hospital. The patient was operated on for a double pyosalpinx, and there was the chance discovery of a Meckel's diverticulum three inches in length, having a well-defined mesentery. The diverticulum showed no evidence of inflammation, but was removed. Recovery resulted.

CASE 2.—J. B., a boy, aged 5 years, was admitted May 21, 1913, to St. Mary's Hospital for Children. He suffered from tuberculosis of the cecum

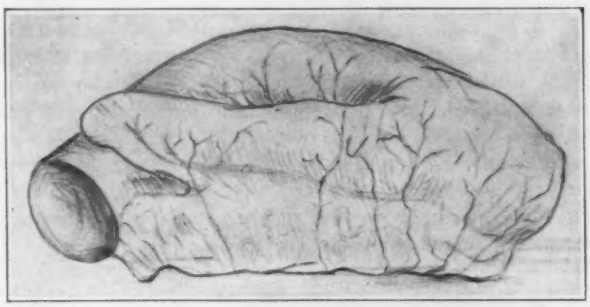

Fig. 1.—Meckel's diverticulum.

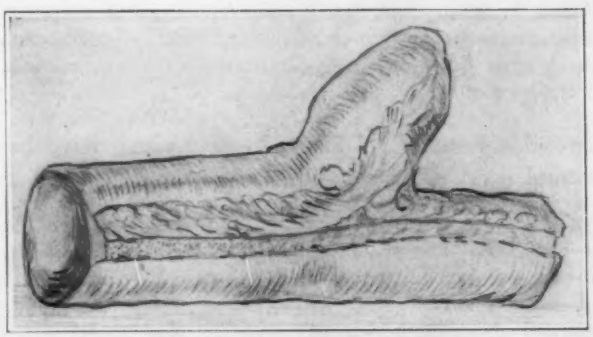

Fig. 2.—Meckel's diverticulum.

with fecal fistula. A Meckel's diverticulum was discovered about an inch and a half in length, and the operation consisted of resection of the cecum and removal of the diverticulum, with suture of the intestine. The patient died.

CASE 3.—A. B., a boy, aged 19 years, was admitted September 15, 1920, to St. Luke's Hospital. This patient had had a series of attacks of pain and vomiting dating back almost to infancy. Nothing about the character of the attacks or roentgen-ray examinations gave any help in diagnosis. The appendix had been removed previously without modification of symptoms. This was the only case in the series in which a Meckel's diverticulum was seriously considered in advance of operation. Though the patient had been in the hands of many doctors and had been submitted to all types of clinical examination, no definite diagnosis had been reached. At operation, the whole abdomen was thoroughly explored. Adhesions about the cecum, which were unusually exten-

sive, were released. The gallbladder was found thick, contracted, and firmly adherent to adjacent structures; but contained no stones. Pathologic report was chronic cholecystitis. In addition, there was a Meckel's diverticulum about two inches long, rather conical in outline, with a diameter at its base of about 1 cm., and attached close to the mesentery. The operation consisted in the separation of adhesions, and the removal of the gallbladder and diverticulum. The latter was found uninflamed. Six weeks after the operation, the attacks began and have continued to date, with slightly diminishing frequency and severity. His medical attendants now think that the attacks are due to some sort of sensitization.

Case 4.—S. A., a man, aged 29, was admitted in February, 1915, to St. Luke's Hospital. The patient had suffered for years from attacks suggesting appendicitis, but which were without temperature. The appendix was found normal but was removed, and in a search for pathologic changes, there was found a Meckel's diverticulum two and one half feet from the ileocecal valve, occupying one third of the circumference of the intestine. The diverticulum was the size of a thumb and one and one half inches in length. At the time, it was thought that the diverticulum was more likely to be the cause of his attacks than the appendix. The result was recovery.

Case 5.—J. F., a man, aged 22, was admitted April 25, 1915, to St. Luke's Hospital. The diverticulum was in the hernial sac. This patient had presented himself for the treatment of a right scrotal hernia, which seemed only partially reducible. The sac, in addition to the omentum, contained a Meckel's diverticulum 6 inches in length and firmly adherent by its distal extremity to the lowest point of the sac in the bottom of the scrotum. Its size was almost equal to that of the normal intestine. The diverticulum was removed, in addition to repairing of the hernia.

A considerable number of Meckel's diverticula have been encountered in hernial sacs, usually inguinal, but occasionally femoral.

Case 6.—G. A., aged three years, was admitted Oct. 5, 1923, to St. Mary's Hospital for Children. The child was sent to the hospital apparently suffering from a case of appendicitis, with a history of cramps for three days, a palpable mass in the right iliac fossa, but no temperature. The operation revealed a normal appendix which was removed, and a Meckel's diverticulum about two inches in length, adherent by its tip to the root of the mesentery, and rotated on its long axis. It was edematous, plum colored, and in places gangrenous. The attachments at its tip and base showed evidence of twisting. Recovery resulted.

The omentum occasionally behaves much as did this Meckel's diverticulum, and when it does undergo axial rotation, it is found that the free end had previously become adherent, usually in a hernial sac.

Recently, I operated on a woman for strangulated inguinal hernia; the content of the sac was a portion of the omentum, adherent at the extremity of the sac and axially rotated. A much larger mass of omentum was gangrenous and twisted within the abdomen. The case was unusual in that strangulation occurred at the origin of the omentum and not at the neck of the sac.

CASE 7.—S. D., a girl, aged 8 years, was admitted in August, 1911, to St. Francis Hospital. This child was admitted to the hospital suffering from a perforated Meckel's diverticulum which had resulted in an abscess in the left pelvis. The diverticulum and a normal appendix were removed, and drainage was established. The diverticulum, in its inflamed condition, was about the size of a little finger, one inch in length, and perforated at its tip. Recovery resulted.

CASE 8.—F. L., a woman, aged 28, was admitted March, 1912, to St. Francis Hospital, suffering from diverticulitis and intestinal obstruction. The patient entered the hospital with a pelvic mass, and at operation a Meckel's diverticulum was found running across a loop of small bowel, obstructing it and adherent to the root of the mesentery. The diverticulum was perforated and gangrenous, and there was an abscess in the pelvis. In this case, it would be difficult to state whether the inflammation of the diverticulum was primary, or whether it resulted from a loop of the small intestine slipping under it and restricting its blood supply. The result was recovery.

CASE 9.—E. H., a boy, aged 6 years, was admitted in December, 1918, to St. Luke's Hospital, suffering from volvulus from Meckel's diverticulum. This child was the son of a physician. He had retired one night apparently well, and in the early morning was seized with severe pains. Shortly after that, his condition was such as to suggest an internal hemorrhage. When he was brought to the hospital during that morning, he was pale, entirely pulseless at the wrist but conscious, free from pain, answering questions but making no voluntary effort, a typical picture of profound shock. A mass could be felt to the right of the umbilicus, and there seemed to be fluid in the abdomen. After the application of external heat and the giving of a clysis, the abdomen was opened, and a Meckel's diverticulum was discovered the size of a hen's egg, with a pedicle no larger than a finger. Twenty inches of small intestine where the diverticulum was attached were purple and strangulated by volvulus. The abdomen was full of bloody fluid. The intestine was untwisted, the diverticulum quickly removed and its bed sutured. The patient died one hour after the termination of the operation.

CASE 10.—G. N., a man, aged about 30, was admitted during August, 1908, to a sanatorium, suffering from an inverted Meckel's diverticulum, and intussusception; resection was performed. The patient had suffered for forty-eight hours with symptoms of obstruction of the bowel, and had been given repeated cathartics and much morphin. A Meckel's diverticulum had inverted into the ileum, and acted as a polyp to initiate an intussusception. This had passed on to the ileocecal valve and through it, and a considerable portion of small intestine was distending the cecum. The mass was reduced out of the cecum into the ileum, which caused it to rupture and made resection necessary. Death followed.

This type of intussusception has long been recognized. Treves[2] has discussed it rather thoroughly. Wellington,[3] among 326 collected cases of diseased diverticula, found that fifty-nine were cases of intussusception initiated by an inverted Meckel's diverticulum acting as a polyp in the lumen of the small bowel.

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2. Treves, Frederick: Intestinal Obstruction, 1901.
3. Wellington, J. R.: Surg., Gynec. & Obst. **16**:75 (Jan.) 1913.

Meckel's diverticulum is rarely concerned with the intussusceptions of children under two years of age; these have their origin mainly about the cecum. After this age, if one encounters an intussusception of small bowel, a diverticulum should immediately suggest itself as the cause.

The infrequency with which tumors of Meckel's diverticula have been described (the whole number not exceeding half a dozen) suggests the propriety of a detailed description of the following case.

CASE 11.—E. S., a woman, aged 44, was admitted March 8, 1919, to St. Luke's Hospital. The patient was a nullipara, in apparent good health, who had recently passed the menopause. She was referred because of a cystic mass in the hypogastrium. The cyst extended from the cul-de-sac of Douglas to about the level of the umbilicus. During the routine examination, the mass suddenly lost its tenseness, and the patient immediately began to suffer severe pain. The pulse was slow and feeble; there was pallor and profuse perspiration. Two hours later, a laparotomy revealed considerable free fluid in the abdomen and a few old clots. The pelvic organs were atrophic. There was a solid tumor attached to the lower ileum by a small pedicle. The attachment was to the side opposite the mesentery. A large vessel from the mesentery crossed the intestine to be lost on the tumor. Removal of the tumor opened the bowel for about an inch. This was closed with two rows of chromic gut sutures without constricting the lumen. Recovery followed.

According to the report on the pathology of the case of Drs. Wood and Knox, the specimen consisted of an abdominal tumor measuring 17 by 11.5 by 7 cm. The surface presented a small quadrilateral area which represented the site of its attachment to the wall of the small intestine. This was approximately 6 by 1 cm. The wall was ruptured, but otherwise the outer surface of the mass was smooth and free from adhesions, being apparently covered by serosa. The growth possessed a solid and a cystic portion, the former being firm, greyish, homogeneous and cellular. The latter was from 2 to 5 mm. in thickness, lined with fibrin and tumor debris, and showed much old hemorrhage. The cystic portion was about three times the size of the solid one. Sections of the tumor showed that it was composed almost exclusively of smooth muscle tissue. The nuclei were rather large. Mitoses were not evident. The cells were rather loosely arranged with frequent vacuoles between them. The muscle bundles were arranged in an interlacing manner so that both longitudinal and cross sections of the muscle were mixed together diffusely. There were numerous thin-walled, vascular sinuses, from some of which there appeared to have been considerable hemorrhage. The portions of the growth lining the hemorrhagic cyst showed the same type of cells, but there was here much necrosis, fibrin and blood.

At the time of operation, this cystic tumor was thought to have originated from a Meckel's diverticulum. At that time, Dr. Symmers'[4] paper recording such a case had not appeared. The reasons for so considering it were: (1) The location of the tumor was not accurately determined, but it was certainly within a few feet of the termination of

4. Symmers, D.: Ann. Surg. **70**:183 (Aug.) 1919.

the ileum; (2) it was a pedunculated tumor attached to the intestine opposite the mesentery, and not involving more than a third of the circumference of the bowel; (3) an artery from the mesentery crossed the bowel, lying free on its surface within a peritoneal investment and was distributed to the tumor. In Meckel's diverticulum, an artery passes to the diverticulum in the same manner, often contained in a definite mesentery of its own.

As will be seen from reading the foregoing report, the tumor was histologically a myoma. Other tumors have usually been reported myosarcoma. Nearly five years later, the patient returned with a recurrence.

CASE 11 (recurrence).—E. S., aged 49, was readmitted Jan. 22, 1924, to St. Luke's Hospital, with recurrent sarcoma of the pelvis. The removal was incomplete. The patient had been in good health, but within the last few months had noted a hypogastric tumor. The chief symptom was pressure on the bladder. The whole pelvis was filled with a globular and somewhat nodular mass the size of a coconut. A hypogastric incision was made. A soft tumor with no anatomical attachment filled the pelvis. It was slightly attached to the omentum and the abdominal wall, and fairly easy to enucleate. After the removal of the main mass, a number of soft, smooth nodules were found adherent to the small intestine, the largest of these being the size of a robin's egg. There was no fluid.

The patient made an uneventful convalescence and left the hospital in fairly good condition. A bi-manual examination later revealed the presence of a considerable mass in the pelvis.

Microscopic sections of the primary tumor (Fig. 3) showed a growth composed largely of smooth muscle with only slight fibrous stroma. The bundles of fibers were twisted and irregular, frequently being placed at right angles to each other. The growth was not very cellular, but there were variations in the size and shape of the nuclei beyond those usually seen in the uterine type of myoma, which it otherwise fairly closely resembled. Fusiform cells with rod-shaped nuclei and rounded ends were found, and occasionally there was a very large vesicular and irregular form. These were not hyperchromatic, however, and mitotic figures were infrequent, being found only after search of many fields. The tumor was moderately vascular and contained only thin-walled sinuses. In portions where hemorrhage had occurred, these sinuses were very large and contained fresh mural agglutination thrombi. Secondary changes due to thrombosis and hemorrhage were seen. Sections of the recurrence (Fig. 4) showed essentially the same type of growth, but one which was noticeably more cellular, there being probably twice as many nuclei in a field. They were also more hyperchromatic, but not larger nor more irregular in form. Mitotic figures were more numerous, though by no means to be found in every field. The vascularity was apparently greater, and the endothelial lining of the sinuses not always so well defined. Supporting connective tissue was smaller in quantity than in the previous tumor. The first tumor was regarded as a leiomyoma, although because of its position the possibility of recurrence was from the pathologic point of view quite possible. The second tumor was morphologically a malignant leiomyoma.

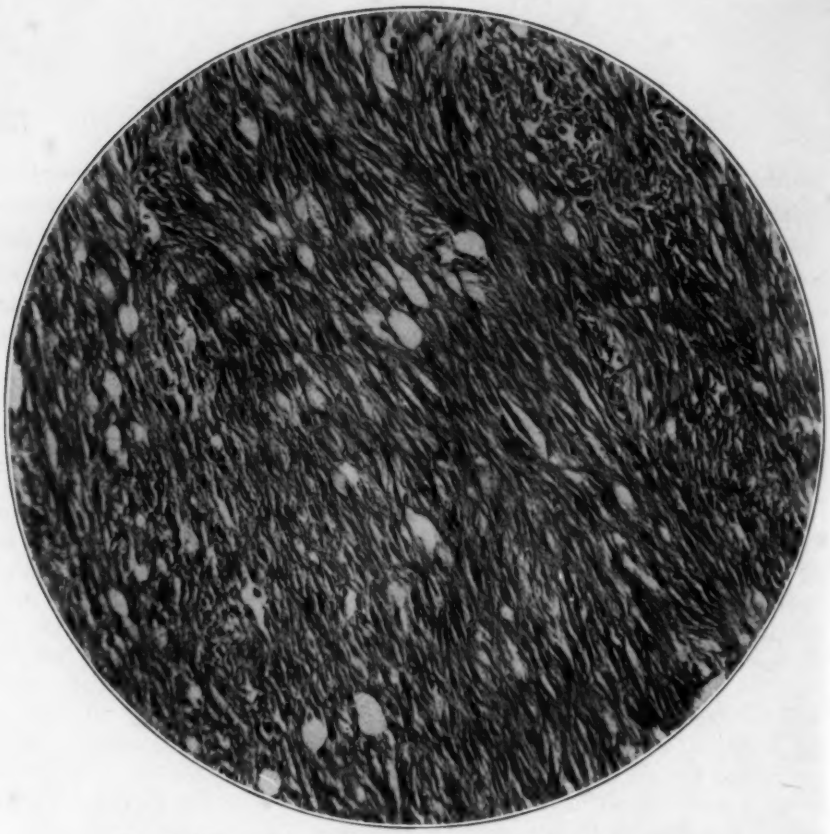

Fig. 3 (Case 11).—Photomicrograph of primary tumor.

Fig. 4 (Case 11).—Photomicrograph of recurrence.

CASE 12.—P., a boy, aged 20 hours, at the Nassau Hospital, Jan. 1, 1923, suffered from hernia into the umbilical cord, and had a Meckel's diverticulum operation. The child at birth weighed seven pounds and seemed normally developed, except that the proximal portion of the umbilical cord contained a hernial sac 3 to 4 inches in length, about the size and shape of a goose egg. The neck was large enough to admit a man's thumb. The sac was translucent. The coils of intestine could be seen freely movable in its anterior. An effort was made to press the contents of the sac back into the abdomen before opening the sac. This proved to be only partially successful. On opening the sac,

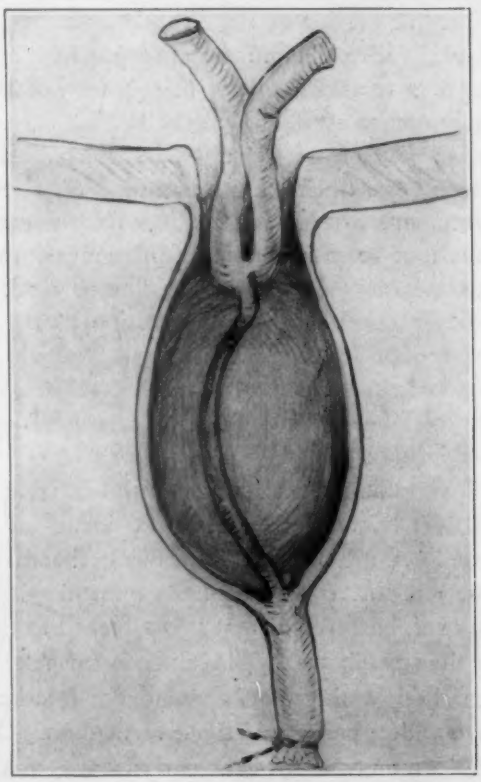

Fig. 5 (Case 12).—Hernia into the umbilical cord.

the explanation became apparent. A loop of small bowel was adherent to itself by its lateral margin. On the margin opposite the mesentery, there was a Meckel's diverticulum 2½ inches in length ending at the farthest limit of the sac, and for the most part lying in the wall of the sac (Fig. 5). The proximal inch of the diverticulum was free in the sac like other portions of the intestine. It was clamped, cut, and inverted into the bowel by means of a pursestring suture. The diverticulum was of uniform diameter with a lumen easily admitting a large director for its whole length. In appearance, it was about half the size of the small intestine. Apparently, nearly all the small intestine was contained in the sac. No omentum or large intestine was seen. No great difficulty was encountered in closing the neck of the sac. The child lived five days.

Its last hours were characterized by attacks of cyanosis followed by crying spells in which the cyanosis was relieved. A partial necropsy was performed by Dr. E. C. Jessup, of Roslyn, who reported a clean operation wound and no other abnormalities of the gastro-intestinal tract. There was a normally patent lumen of the intestine at the site of the invaginated stump. The testes were markedly undescended, lying about one-half inch below the lower pole of the kidney. The heart showed no abnormality.

Dr. Lucius Wing [5] has recently operated successfully on a case of hernia into the umbilical cord, which contained in addition to the small intestine, a considerable portion of the infant's liver.

Though a Meckel's diverticulum has always originally been attached to the umbilicus, it is remarkable how infrequently it remains so. In this series, the only one so attached was the twelfth case. On the other hand, in a large proportion of the cases in which obstruction results from a diverticulum, the diverticulum is found attached by its tip to some adjacent structure, as for instance, to the mesentery or hernial sac. Lateral adhesions seem surprisingly infrequent, and the terminal adhesion is sometimes described as a long fibrous cord. There seems to be no anatomic or developmental explanation of the attachment of this cord elsewhere than at the umbilicus, and it would seem probable that the cord at some time becomes detached from the umbilicus, then floats free in the abdominal cavity, and later establishes a secondary adhesion to other structures.

A Meckel's diverticulum is an enormously variable structure. In the foregoing cases it has varied from 1 to 6 inches in length. Many have shown a well-defined mesentery, drawing the diverticulum over to the side of the intestine from which the mesentery originates. The usual description of it, however, is that it is attached to the side opposite the mesentery of the small bowel. The lumen is variable. There is very rarely any constriction at the attachment to the intestine. More frequently, this is the widest portion of the diverticulum. Occasionally, an angulation or fold of mucosa forms a partial valve at the junction of diverticulum and intestine. In such cases, intestinal contents and foreign bodies are likely to be retained in the diverticulum and set up irritation or inflammation.

A recent case in the literature records an obstruction due to fecal impaction in the diverticulum, causing an obstructing angulation at the site of attachment. This patient was treated by reducing the contents of the diverticulum into the bowel without removing the diverticulum.

Dr. Charles Peck found a Murphy button lodged in a Meckel's diverticulum. A remarkable case not likely to be duplicated is that of

5. Personal communication.

Brodnax.[6] In a dissecting room subject, he found a sciatic hernia passing out through the greater sciatic foramen. This hernia contained an adherent Meckel's diverticulum 10 cm. in length, whose other attachment was to the ileum two feet from the ileo-cecal valve.

In this series of cases, the diverticulum has always been removed, whether a pathologic condition existed or not. The propriety of the procedure can hardly be questioned except possibly in Case 2, where extensive tuberculosis of the cecum required resection of the intestine, and death resulted. There is no reason to think that the result would have been different in this case had the diverticulum not been removed, but one would consider it wiser not to add such an operative procedure in a desperate case. In all other cases, whether it is diseased or not, it should be removed; my individual experience leads me to believe that in a great majority of cases where it is present, it will sooner or later give rise to symptoms. The attachment of a diverticulum to the intestine does not involve more than a third of the circumference of the bowel, and usually less, the diverticulum usually being much smaller than the intestine from which it springs. Hence, in the uninflamed, it can always be removed and the defect closed without necessitating an intestinal resection.

In the nine cases in this series giving clinical symptoms, three resulted fatally. In Wellington's collected statistics, there are recorded 179 deaths, 129 recoveries, and in twenty-one cases the result is not stated. The ways in which a Meckel's diverticulum may give symptoms are so numerous that it seems unlikely that a case would be diagnosed with any certainty in advance of operation, except in the very rare cases of umbilical anus. In the one case in the foregoing list in which a diverticulum was considered and found, the outcome demonstrated that the diverticulum was not related to the symptom complex. However, if one keeps the possibility of a Meckel's diverticulum in mind and looks for it in the course of abdominal explorations, the search may be rewarded, as it was in Case 4, by the discovery that a diverticulum is the cause of the symtoms.

This paper is presented because of the unusually large number of cases encountered by one operator, and for the purpose of calling attention to the variety of clinical symptoms resulting from a Meckel's diverticulum.

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6. Brodnax, John W.: Sciatic Hernia: Report of a Case of Hernia of Meckel's Diverticulum Through the Greater Sciatic Foramen, J. A. M. A. **82**:440 (Feb. 9) 1924.

THE TREATMENT OF FRACTURES OF THE SHAFT OF THE FEMUR IN CHILDREN

A REPORT OF THIRTY-TWO CASES

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The general concensus of opinion relative to the treatment of fractures of the shaft of the femur in children seems to be that good functional results may be obtained by the universal application of one or two of the methods now commonly used. Although this may be true to a great extent, we believe that each case should be handled as a separate problem, that the type of treatment instituted should depend on the character of the fracure and the age of the child, and that by the proper application of the most suitable type of treatment we can more nearly approach anatomical results. With these thoughts in mind, we have made a study of and are reporting the thirty-two cases of fracture of the shaft of the femur in children under 12 years of age who were treated in the Cincinnati General Hospital between Feb. 1, 1922, and Jan. 1, 1924.

Description of Cases.—The youngest patient in the series was 12 days, and the oldest, 11 years of age. There were two patients, or 6 per cent., under 1 year; four patients, or 12 per cent., between 1 and 3 years; eleven patients, or 34 per cent., between 4 and 6 years; nine patients, or 28 per cent., between 7 and 9 years, and six patients, or 17 per cent., between 10 and 12 years. Nine cases, or 28 per cent., were in females and twenty-three cases, or 72 per cent., were in males. Fifteen, or 47 per cent., were transverse fractures; nine, or 28 per cent., were oblique fractures; two, or 6 per cent., were spiral or spiral-oblique fractures; and four, or 12 per cent., were comminuted fractures. Three, or 9 per cent., were compound fractures, and the remainder were simple fractures. Five, or 15 per cent., of the fractures were of the upper third; twenty-two, or 70 per cent., were of the middle third; and five, or 15 per cent., were of the lower third. The fractures of the upper third most frequently showed anterior and external displacement of the upper fragment. In one case the upper fragment was anterior and internal and in another it was posterior and internal. The fractures of the middle third practically all showed anterior and lateral or internal displacement of the upper fragment. The fractures of the lower third showed posterior displacement of the lower fragment in all except one case.

TREATMENT

I. Reduction attempted: eighteen cases.

1. Successful reduction with one attempt: twelve cases.

(*a*) Upper third: two cases, both transverse.

Emergency board splint, later reduction and immobilization in a double spica cast: one case, no shortening.

Emergency board splint, later reduction and immobilization in a Mechano splint: one case, no shortening.

(*b*) Middle third: seven cases, all transverse.

Immediate reduction and immobilization in the Mechano splint: two cases, no shortening.

Emergency Mechano splint, later reduction and immobilization in the Mechano splint: one case, 0.5 cm. shortening.

Emergency board splint, later reduction and immobilization in the Mechano splint and in a single spica cast on discharge: one case, no shortening.

Immediate reduction and immobilization in the double spica cast: one case, no shortening.

Bryant's extension after immediate reduction: two cases, no shortening.

(*c*) Lower third: three cases.

(1) Transverse: two cases.

Emergency Mechano splint, later reduction and immobilization in a double spica cast: one case, 0.3 cm. shortening.

Débridement of soft parts, closed reduction and immobilization in the Mechano splint: one case, no shortening.

(2) Oblique: one case.

Emergency Mechano splint, later reduction and immobilization in a double spica cast; no shortening.

2. Reductions unsuccessful with one attempt: six cases, all transverse.

(*a*) Middle third: five cases.

Reduction and immobilization in a double spica cast, and two subsequent attempts with a double spica cast: one case, 0.5 cm. shortening.

Reduction in the Mechano splint and two subsequent attempts with double spica cast: one case, 2.5 cm. shortening.

Emergency Mechano splint and reduction two days later with immobilization in a double spica cast: one case, 2.5 cm. shortening.

Reduction and immobilization in a double spica cast and subsequent Bryant's extension: one case, amount of shortening not recorded.

Successful reduction and immobilization in a double spica cast after two trials: one case, no shortening.

(*b*) Lower third: one case.

Reduction and immobilization in a double spica cast, with two subsequent manipulations and traction in a splint; 1.25 cm. shortening.

II. Treatment by traction without manipulation: fourteen cases.

One of these cases was a transverse fracture of the middle third which was treated in Bryant's extension without shortening.

The remainder were either oblique fractures or unknown in type.

(*a*) Upper third: two cases.

Bryant's extension: one case, 0.5 cm. shortening.

Bryant's extension for fourteen days followed by immobilization in a double spica cast: one case, 1 cm. shortening.

(*b*) Middle third: ten cases.

Bryant's extension: four cases, 0 to 0.5 cm. shortening. (One patient left the hospital in less than seven days.)

Bryant's extension eleven to fifteen days followed by double spica casts: two cases, 0 and 0.5 cm. shortening.

Bryant's extension for three days followed by immobilization in a Mechano splint: one case, 1 cm. shortening.

Immobilization in a Mechano splint for thirteen days, followed by immobilization in a double spica cast: one case, no shortening.

Shock cases treated with emergency board splints: two cases, death resulted.

(*c*) Lower third: one case.

Bryant's extension, 1 cm. shortening.

Hospitalization Period.—The average hospital stay was forty-six days.

Immobilization Time.—The average immobilization period for all cases was thirty-eight days. The average period for cases treated in Bryant's extension was thirty days, and the average term for four cases between 10 months and 4 years of age treated throughout in Bryant's extension was twenty-six days. This does not necessarily mean that earlier union is obtained in Bryant's extension. With this form of treatment where the limb is readily palpated, immobilization is discontinued when union is firm rather than at the end of a time limit. In infants, immobilization is apt to be discontinued earlier because it is always difficult to demonstrate slight false motion in the femur of a young infant.

RESULTS

1. *Condition on Leaving Hospital.*—Shortening: Of twelve successful reductions with one attempt and with immobilization chiefly in the Mechano splint or in the double plaster spica cast, there was measured a shortening of 0.5 cm. in only one case.

Of five unsuccessful reductions which were treated largely in double spica casts there was an average shortening of 1.45 cm.

Of twelve cases, chiefly oblique, treated in Bryant's extension or in traction splints, there was an average shortening of 0.43 cm.

Thus, it is definitely shown that our greatest shortening resulted in the cases which were reduced and immobilized in the double spica cast.

Angulation: Gross angulation of slight degree was noted in only three cases on discharge, all of which had been treated in casts.

Callus: Usually there was considerable palpable callus on discharge. Our records on this subject are not complete enough to determine

whether the amount of callus which develops depends in any way upon the type of immobilization. There were no cases of delayed union in our series.

Joint Motion: Motion of the hip joint seems to be affected only in high upper third fractures, and in these cases there is only slight limitation.

In fractures of the middle third treated in Bryant's extension or in the double spica cast, there is usually 50 per cent. limitation of motion of the knee joint, which returns to normal within three or four months.

In low fractures of the lower third, the motion of the knee joint is markedly limited, but here also it rapidly returns to normal.

2. *Late Results.*—Of fourteen patients whom we examined in from three to twenty-seven months after discharge, we found only two patients who had the slightest limp.

Two patients who were discharged over twelve months previously with shortening of 0.5 cm. and 1 cm. failed to show any shortening on their return. Two patients who had had 1.25 cm. and 2.5 cm. shortening returned with only 0.5 cm. and 1 cm. of shortening. One discharged twenty-seven months previously with no shortening showed on returning 0.5 cm. of lengthening.

Two patients who very likely started weight-bearing in less than three months after the date of their injury had developed some bowing after leaving the hospital.

Within five or six months, excessive callus is absorbed and the roentgen-ray picture shows a smooth even union of the ends of the fragments.

Joint motion was normal in all except two recently discharged patients, one of whom, after a fracture of the lower third, left the hospital with flexion at the knee limited to 35 degrees, and returned within three months with flexion to within 15 degrees of normal.

These few late results lead us to conclude that shortening of from 0.5 to 1.5 cm. entirely disappears in from one to two years, that weight-bearing should never be started under three months, that excessive callus is rapidly absorped, and that limitation of joint motion is only a temporary condition.

DISCUSSION OF METHODS

Our experience with recent cases and the results of the above analysis have lead us to formulate certain ideas relative to the application of various methods of immobilization.

Unless our cases are associated with other serious injuries and shock we immediately fluoroscope the limb. If the fracture is transverse, immediate reduction is attempted. If it is oblique, we immediately

place the limb in the type of traction decided upon. With cases in moderate shock immobilization in the Mechano splint with considerable traction is employed. With cases in severe shock immobilization with a board splint extending to the axilla is used.

Although our records show that we have made a number of successful reductions after immobilization for two or three days in a temporary splint, and while it is possibly true that immediate reduction and traction is not as essential in children as it is in adults, we are convinced that reduction is easier effected and should be attempted before swelling and infiltration of the tissues has occurred. Therefore, if the condition of the patient permits we attempt a reduction immediately.

With patients under one year of age, our experience has been very limited. In the one case of a very young infant whom we treated in a double spica cast with the thighs flexed at right angles to the body union with over-riding developed. We are inclined to believe that, in infants under one year of age, immobilization in the Van Arsdale triangular splint is, generally speaking, the best form of treatment. This splint keeps the thigh flexed at right angles to the body with the amount of abduction desired, and leaves the leg free below the knee. As described by Gallant,[1] no particular attempt is made to effect an anatomical reduction. He quotes Percival Pott's "physiological doctrine" that the resistance of muscles producing shortening can be overcome by posture without the aid of extension. As described by Gallant, the method was utilized in children up to the age of five years, but we are convinced that in children over one year of age better anatomical results can be obtained otherwise. The advantage of the method is that it interferes very little with the nursing and care of the child.

In children from one to five years of age, we believe that all types of fracture of the shaft of the femur with the exception of those of the lower third can best be treated in Bryant's extension. We have successfully used this method in infants as young as ten months. It is particularly ideal in fractures of the middle and upper thirds where the upper fragment is usually anterior. We place the adhesive traction straps up to the level of the fracture. Enough weight is used to keep the buttocks just a little off of the bed. Only one leg is suspended so that we obtain the maximal traction. Both legs are suspended only in young infants where it may become necessary to prevent excoriation of the buttocks. As advised recently by Burdick and Siris,[2] we approximate the ends of the fragments in transverse fractures before the leg is suspended.

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1. Gallant, A. Ernest: Van Arsdale's Triangular Splint in Thirty-Three Cases of Fracture of the Femur in Infants and Children Under Six Years, J. A. M. A. **29**:1239 (Dec. 18) 1897.

2. Burdick, C. G., and Siris, I. E.: Ann. Surg. **77**:736-753 (June) 1923.

We do not find that it is necessary to use coaptation splints along the thigh. The method requires careful observation to prevent pressure sores about the ankle. Using Bryant's extension in these small children we can always obtain union with less than 1 cm. average shortening.

In children between the ages of 5 and 10 years, our treatment of fractures of the middle and upper thirds depends upon the character of the fracture. If the fracture is transverse it is reduced and immobilized in what we call the "Mechano splint." This splint (Fig. 1) is merely

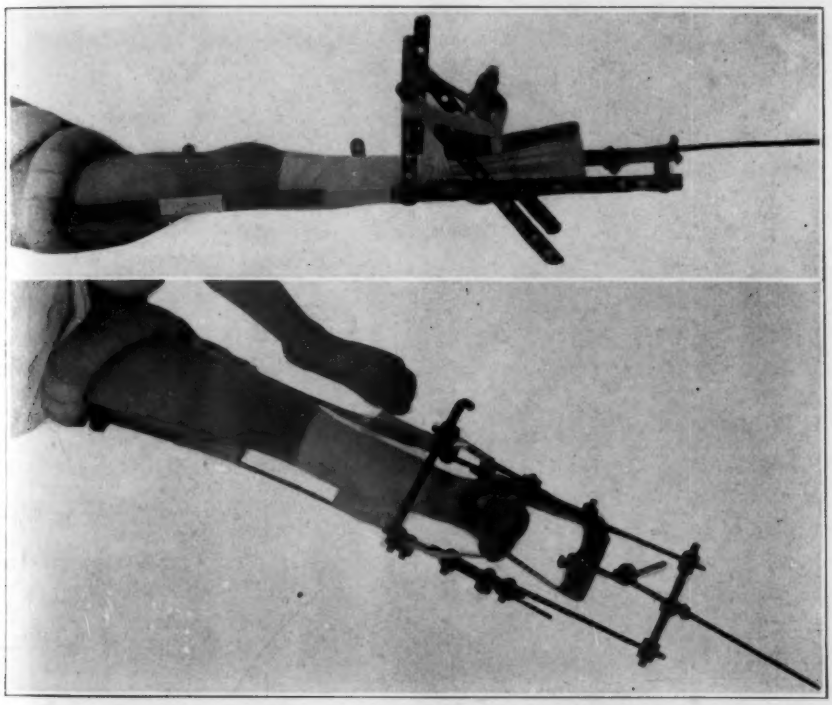

Fig. 1.—Lateral and dorsal views of the Mechano splint.

an adjustable Thomas splint for children, which was devised independently by Dr. John A. Caldwell of this clinic in 1920 but never reported because of the appearance of the Ever-ready splints devised by French, the only account of which we can find being a description by Chapman.[3] We apply the Mechano splint and then reduce the fracture on the fluoroscopic table. Slings are arranged to support the leg properly, and sometimes are utilized to hold the fragments in apposition. For a week or two the leg is kept rather snugly laced in the splint. Just enough traction is used to immobilize the leg, very little being

3. Chapman, F. E.: Modern Hospital **15**:152 (Aug.) 1920.

necessary in these transverse fractures. The ring of the splint is padded and protected with oiled silk to keep it dry. Only in one recent case have we had trouble because of excessive soiling of the ring. We find that slipping of the fragments enough to result in over-riding seldom occurs. The patient is taken to the fluoroscopic room every few days

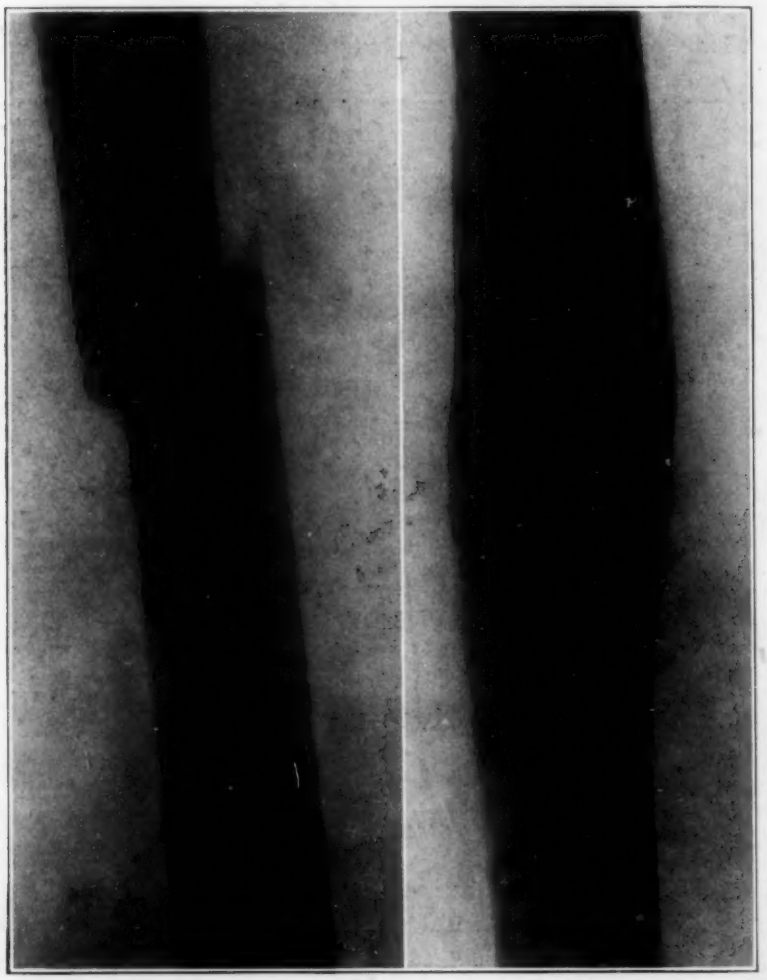

Fig. 2.—Slightly oblique fracture of the middle third in a boy aged 10 years, treated by an emergency Mechano splint with reduction five days later, and immobilization in the Mechano splint. The result after reduction (left), and fourteen months later (right).

for the first two weeks. He can sit up readily in bed, he can be moved from the bed to the stretcher with perfect safety, the splint may be suspended in bed if desired and abduction may be used if it is helpful.

In several cases we have used this splint for two or three weeks, and have then sent the patient home in a single or double plaster spica cast. We have also used the splint in cases of compound fracture, which have been subjected to débridement and reduction. It is particularly adaptable to middle third fractures (Figs. 2, 3 and 4). We have also

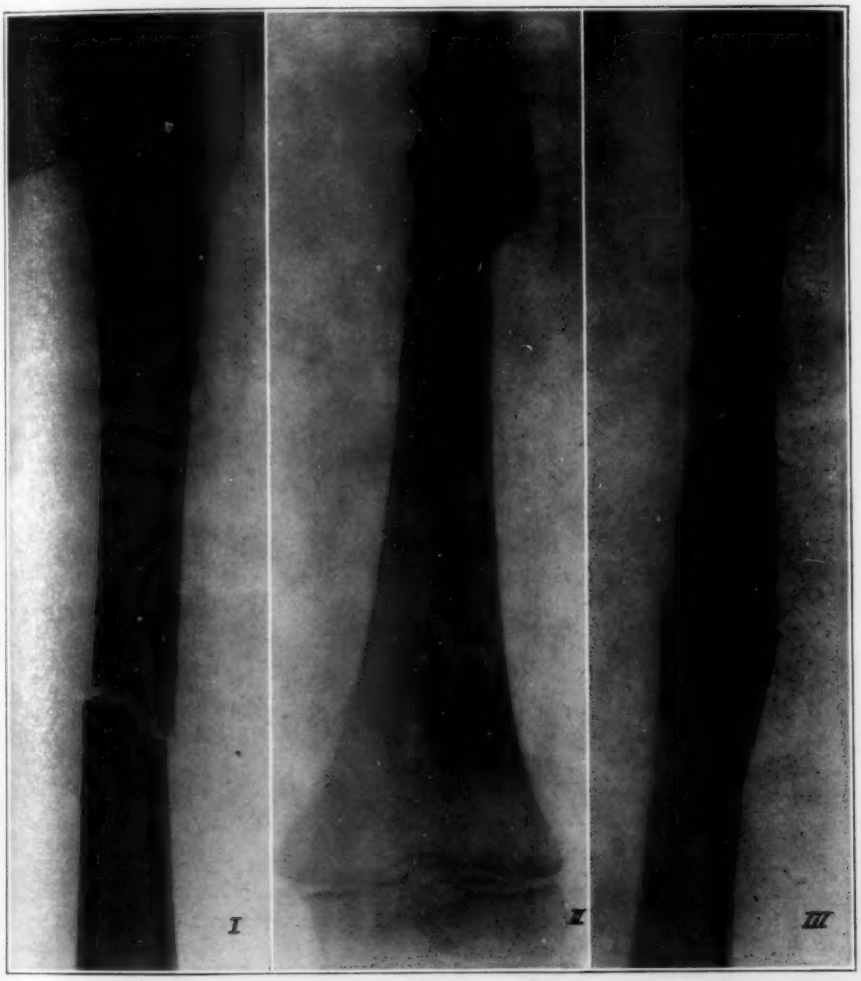

Fig. 3.—Transverse fracture of the middle third in a boy, aged 6 years, treated by immediate reduction and immobilization for forty days in a Mechano splint. Results: *I*, after reduction; *II*, on leaving the hospital, and *III*, on returning six months later.

used it successfully in one transverse fracture of the upper third (Fig. 5). In no cases have we seen excoriation or ulceration of the perineum. The splint is not adaptable to females, for whom we substitute an iron stirrup held in place by a snug plaster ring about the thigh.

The other method for treating transverse fractures in children between 5 and 10 years of age is reduction and immobilization in the double spica cast. We agree with Speed [4] that this is a most undesirable method, and in our hands it has given the poorest results. Its disadvantages are that the fragments often slip, that it is difficult to handle or fluoroscope the limb and that malposition, if it occurs, is not discovered for a week or more, when attempts at reduction are

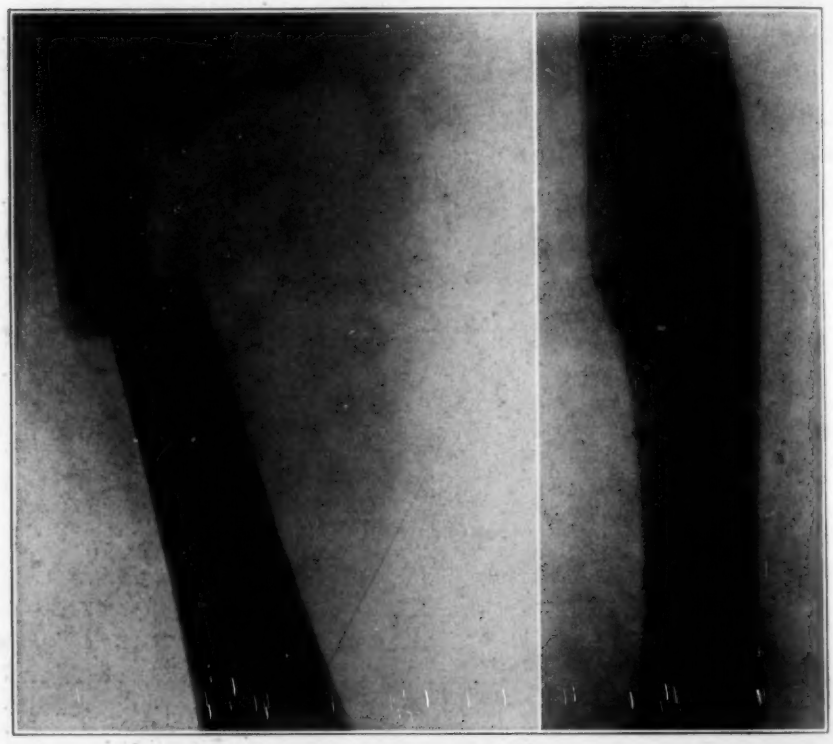

Fig. 4.—Transverse fracture of the middle third in a boy, aged 10 years. Immediate reduction and immobilization in the Mechano splint were used. The patient was discharged in a single spica cast. Result: after reduction (left); on return five months later (right).

futile, the result being union with from 1 to 2.5 cm. of shortening. When we do resort to the cast method we always use the double plaster spica, completely surrounding the affected limb and the thigh of the unaffected limb. The cast is carefully trimmed, the patient is turned face downward twice daily for an hour, and if the patient is an infant,

4. Speed, K.: Surg., Gynec. & Obst. **32**:527 (June) 1921.

the buttocks are suspended over a gap between two folded mattresses to prevent soiling of the cast.

In the treatment of oblique fractures of the shaft of the femur in children between 5 and 10 years of age, we again resort to Bryant's extension and we have been able to obtain good functional results with less than 1 cm. of average shortening. It is applicable to fractures of the middle and upper third (Fig. 6).

Fig. 5.—Transverse fracture of the upper third in a boy, aged 6 years, associated with other injuries and shock; treated three days in an emergency board splint, reduced and immobilized in a Mechano splint for twenty-three days, followed by an iron stirrup with plaster about the thigh for twelve days. Results: on discharge (left), and six months later (right).

Fractures of the lower third of the shaft of the femur in children of all ages, unless they are of such transverse character that the ends of the fragments can be securely approximated, constitute a separate problem. Treated in Bryant's extension or in extension splints the lower fragment tends to be pulled backward by the gastrocnemius muscle. We have treated these fractures by using the double plaster spica with the knee flexed to 45 degrees. In one recent case, a window was cut anteriorly in the cast just above the knee and, by means of a

Fig. 6.—Oblique fracture of the upper third in a boy aged 7 years, associated with other injuries and shock. The emergency Mechano splint was used for two days, and Bryant's extension for thirty-two days. Results: *I*, shortly after admission; *II*, on discharge, and *III*, on return three and one-half months later, with 0.5 shortening.

sling and a windlass, traction was exerted to lift the lower fragment forward (Fig. 7). This method must be used with great care in order to prevent injury from pressure in the popliteal space. The unusual cases in which the lower fragment is forward and in which the oblique fracture line runs from behind, upward and forward, may be treated in Bryant's extension. We have never had to resort to open reduction in the treatment of fractures of the lower third. In our opinion, this is the only type of simple fracture of the shaft of the femur in children

where an open reduction would be justified, and then only after an unsuccessful attempt with a closed method.

In children over ten years of age, the problem of the treatment of fractures of the shaft of the femur becomes comparable to that in adults. Bryant's extension is no longer applicable because of the tension on the hamstring group of muscles. In general, the cases recorded here have been treated in the Mechano splint or in the double spica cast. However, in two recent cases not included in this series balanced traction was used, a method which is used in all of the adult cases, and which has recently been reported by Dr. Andrus of this clinic. Both these patients were discharged without measured shortening.

We immobilize our femur cases in children for from 4 to 6 weeks. Then, if the patient is under 6 years of age, he is merely kept from

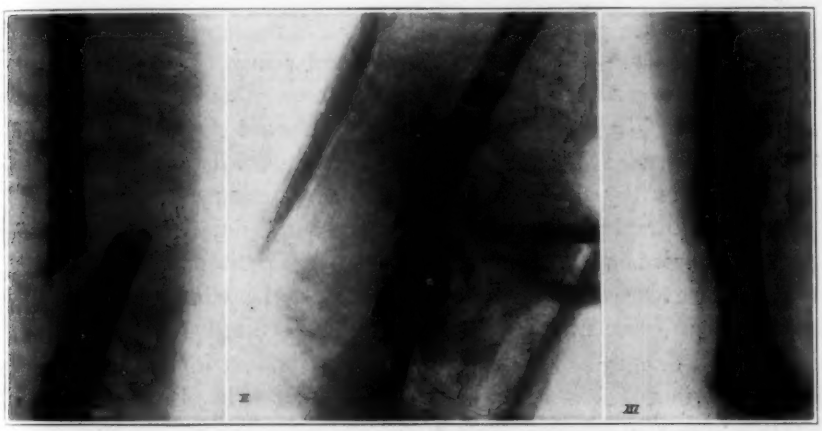

Fig. 7.—Oblique fracture of the lower third in a boy aged 5 years, associated with shock and cerebral concussion. The emergency board splint was used for two days, and Bryant's extension for three days; reduction and immobilization in double spica cast with knee flexed at 45 degrees. Sling and windlass were used to help hold lower fragment forward. Results: *I*, before reduction; *II*, after reduction, and *III*, on return five and one-half months later.

walking or standing, and if he is over 6 years of age, he is provided with a splint consisting of an iron stirrup held in place by plaster about the thigh. In older children, this may be made as an ambulatory splint. Weight bearing is not allowed under three months.

CONCLUSIONS

1. Each fracture of the femoral shaft in children should be handled as a separate problem.

2. The choice of the type of treatment should be governed by the character and location of the fracture and the age of the child.

3. Immediate reduction and immobilization should be attempted.

LYMPHATICOSTOMY

AN EXPERIMENTAL AND CLINICAL STUDY OF THORACIC DUCT DRAINAGE IN GENERAL PERITONITIS *

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The high mortality from general suppurative peritonitis is a problem with which every internist and surgeon has been confronted. Any procedure that promises a reduction in this mortality is worthy of serious study.

The results in general purulent peritonitis rest entirely on the ability of the peritoneum to overcome the particular infection; and treatment consists in affording the peritoneum every possible aid in the performance of this protective function. Such aid may be summed up under four heads: (1) removal of the focus of infection; (2) rest of the peritoneum by the greatest possible elimination of peristalsis; (3) placing parenterally at the disposal of the body, fluid and nourishment, and (4) increasing the blood supply to the peritoneum by the local application of heat. Somewhat the same may be said of the treatment of intestinal obstruction, although here is recognized the predominating factor of a definite source of toxemia to be relieved. The toxemia of general peritonitis has not been so recognized. It has been classed with the toxemias of other infections, to disappear when the infection is overcome; or not to disappear if the infection is not overcome.

Costain, in 1922,[1] attacked this problem from a new point of view, namely, that the toxemia in general peritonitis per se could be reduced, and that when the toxemia was so reduced, the peritoneum was placed in better position to make effective its protective powers. On the assumption that the toxin elaborated within the peritoneal cavity is taken up by the lymphatics and enters the circulation by way of the thoracic duct, Costain attempted to carry the greater portion of the toxin outside the body by draining the thoracic duct.

This seems to be a unique proceeding. The literature on the subject is meager. One case of drainage of the thoracic duct for therapeutic purposes is recorded. Wilms in 1910[2] drained the lymphatic duct in a

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* From the Department of Surgery, Washington University School of Medicine, and the St. Louis City Hospital.

1. Costain, W. A.: Septic Absorption in Diffuse Septic Peritonitis, Canadian M. A. J. **12**:789 (Nov.) 1922.

case of fat embolism, and the patient recovered. Murphy and Brooks [3] have recovered a lethal quantity of the toxin of experimental intestinal obstruction from the thoracic duct.

In a control series of seven dogs, Costain [1] established what he believed to be a uniformly fatal peritonitis within two days, as reported below. This he accomplished by the ligation of the appendix and mesoappendix in dogs under aseptic precautions. In two experimental series, one of eleven dogs and one of seven dogs, this procedure was followed immediately in the first group by ligation of the thoracic duct, and in the second group by opening of the thoracic duct twenty-four hours later. Of the first series of eleven dogs, four developed a thoracic duct fistula. These four survived. In the second series of seven dogs, three developed a thoracic duct fistula and survived. Encouraged by these results, Costain [4] later opened and drained the thoracic duct in a child suffering from pneumococcus peritonitis which he considered otherwise almost certainly fatal. The patient recovered. The peritoneum was not opened, but the organism was identified by aspiration. The duct fistula closed spontaneously in about six days. Costain feels that these results, experimental and clinical, are rather favorable to the use of the method in cases in which the clinical prognosis is bad.

The importance of this conclusion in a type of case in which any procedure of real merit deserves recognition makes it essential that the whole proceeding be reviewed experimentally and clinically by independent investigators. The present work is the record of such a review. We have repeated Costain's experiments with general peritonitis from gangrene of the appendix, and have added thereto a series of experiments on intestinal obstruction from the establishment of a short, high isolated loop of intestine. In addition, we report a single clinical case in which one of us applied the principle under discussion.

The repetition of Costain's work as carried out closely followed the description of his method in his second group of experimental animals. Experiments on twenty-eight dogs, divided into a control and an experimental series, are recorded, although a much larger number was employed. No data were recorded from dogs which either complications, such as pleural injury or death from anesthesia, or a doubt as to the proper opening of the thoracic duct, rendered undesirable for observation. In the fourteen control dogs, the abdomen was opened under ether anesthesia with aseptic precautions, and the appendix was identified. The

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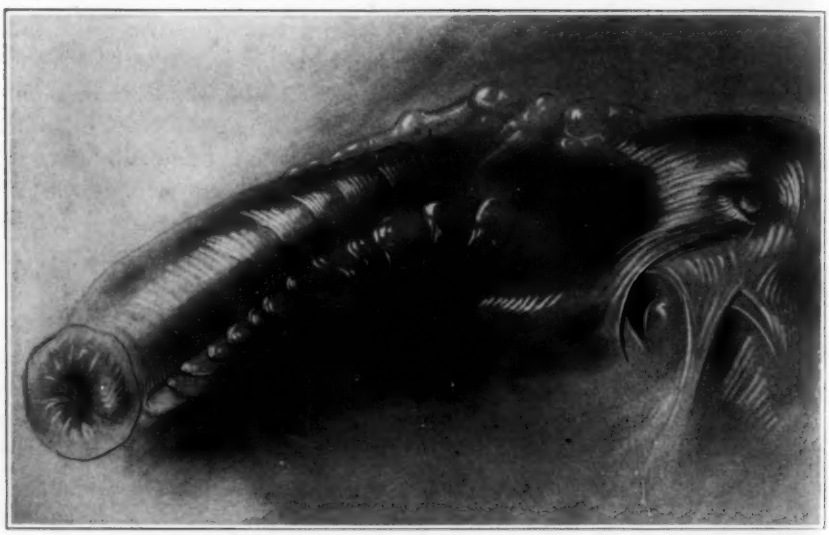
2. Wilms: Cor.-Bl. f. schweiz. Aerzte **40**:197, 1910; Traitement de l'embolie graisseuse, Semaine méd., 1910, p. 138.

3. Murphy, F. T., and Brooks, Barney: Intestinal Obstruction, Arch. Int. Med. **15**:392 (March) 1915.

4. Costain, W. A.: Lymphaticostomy in Peritonitis, Surg., Gynec. & Obst. **36**:365 (March) 1923.

mesoappendix was perforated with a needle carrying a ligature, which was then used to ligate the mesoappendix and the base of the appendix. These dogs were then replaced in the cages, and the day of death was recorded. In the experimental series of fourteen, this procedure was also carried out. The dogs were given a half pint of cream as an aid to identifying the thoracic duct about twenty hours after laparotomy, but they frequently vomited it all immediately. Four hours later, the thoracic duct was dissected out and severed, and a drain was placed in the stump. Isolation of the duct was found difficult; and in a certain number of



Lower ileum and cecum of Dog 7 removed at exploratory laparotomy fifty-one days after ligation of the appendix. There was no evidence of peritonitis except adhesions about the cecum. The appendix was represented by the fibrous nodule shown in the sketch.

cases the duct was never identified. These cases are not recorded. All experiments in which the dogs died were checked by postmortem examination. In those which survived, an exploratory laparotomy confirmed the destruction of the appendix, which was represented by a small nodule of fibrous tissue, as shown in the accompanying illustration.

Our results in this portion of the work differ from those of Costain in two important particulars as may be seen in the accompanying tables. Because there were seven consecutive fatalities within forty-eight hours following the ligation of the appendix and its vessels, he accepted this procedure as control for his experimental work, feeling that he had established an absolutely lethal procedure within a definite period. That

this is not necessarily so is shown by our data. In a control series of fourteen dogs (Table 1) in which the appendix was definitely rendered gangrenous, four dogs recovered spontaneously. The average duration of life of the remaining ten dogs was 4.2 days. The second disagreement concerns the fourteen experimental dogs (Table 2), in which the thoracic duct was drained twenty-four hours after ligation of the appen-

TABLE 1.—*Controls*

Dog	Length of Life in Days	
1	alive	The appendixes of the control dogs were ligated. Four of the fourteen dogs survived. The average length of life of the remaining 10 dogs was 4.2 days.
2	2	
3	12	
4	3	
5	alive	
6	3	
7	alive	
8	4	
9	2	
10	2	
11	alive	
12	4	
13	8	
14	2	

TABLE 2.—*Experimental Data*

Dog	Length of Life in Days	
15	2	Fourteen dogs underwent drainage of the thoracic ducts 24 hours after ligation of the base of the appendix and the mesoappendix. The average length of life was 2.7 days.
16	2	
17	3	
18	2	
19	2	
20	4	
21	2	
22	2	
23	2	
24	2	
25	2	
26	8	
27	3	
28	2	

dix, none surviving, and the average duration of life, 2.7 days, being measurably shorter than that of the controls. In these experiments, the thoracic duct drained continuously up to the time of death.

Granted that the series is sufficiently large to warrant deductions, the explanation of this difference in favor of the control over the experimental dogs must be the added anesthesia and dissection which the experimental dogs underwent twenty-four hours after the onset of the disease. From our data, it becomes clear that (1) Costain's control series was

not large enough to warrant conclusions, and (2) his recoveries following thoracic duct drainage cannot be ascribed entirely to such drainage, as recovery can occur under the given conditions spontaneously. The conclusions that we must draw from this portion of our experimental results are that (1) in dogs, the drainage of the thoracic duct has no appreciable favorable effect on the course of general peritonitis, the result of appendiceal gangrene; and (2) the added operative procedure has a distinctly unfavorable effect.

The second portion of experimental work deals with the results of thoracic duct drainage in fourteen dogs following an isolated loop obstruction, as compared with fourteen controls. An attempt was made to establish a rapidly fatal lesion by making a high, short loop. Under ether anesthesia, with careful asepsis, the abdomen was opened and the duodenum picked up. A uniform distance from the pylorus of 45 cm. was then measured off and a crushing clamp applied. On account of varying contraction of the intestine and differences in size of the dogs, this measurement and the one that follows are not considered absolutely comparable in all the animals. The actual difference in effect on the survival period cannot be marked. The second crushing clamp was applied 15 cm. below the first. The isolated loop was then severed without altering the blood supply; the ends were inverted, and the loop was returned to the abdomen. An end to end anastomosis was made of the proximal and distal ends of the intestine, and the abdomen was closed without drainage. These dogs all died promptly (Table 3), the average duration of life of fourteen dogs being 2.3 days. Postmortem examination revealed in every instance a rupture of the obstructed loop, with an early general peritonitis. Undoubtedly, the toxin developed within the loop played the major part in the fatality by absorption both from the loop before rupture and from the peritoneal surface after rupture. The known escape of obstruction toxin through the thoracic duct [3] renders the application of the principle reasonable. Consequently, the thoracic duct procedure as described in our first series was carried out on fourteen dogs in which obstruction had been established (Table 4), twenty-four hours after the isolated loop was made. As may be seen, these dogs lived an average of 3.8 days. If the single long survival (Dog 43, thirteen days) is omitted, the average drops to 3.1 days. However, either way the figures are read, there remains a distinct difference between the two series. At the same time, one notes no recoveries following the establishment of a thoracic duct fistula.

The conclusion to be drawn from this series of experiments is that lymphaticostomy may exert a slightly favorable influence on the course of an obstruction toxemia produced by the formation of a high obstructed loop.

Previous to undertaking this experimental work, one of us encountered a case of general peritonitis in which the prognosis seemed almost absolutely bad. With Costain's single successful case in mind, the application of thoracic duct drainage was decided on. The case record follows:

REPORT OF CASE

History.—E. S., man, aged 27, white, married, a laborer, entered St. Louis City Hospital, May 6, 1923, complaining of abdominal pain. He had never

TABLE 3.—*Controls*

Dog	Length of Life in Days	
29	3	Fourteen dogs with a 15 cm. isolated high jejunal loop lived an average of 2.3 days.
30	3	
31	3	
32	1	
33	2	
34	2	
35	2	
36	1	
37	2	
38	5	
39	3	
40	2	
41	2	
42	2	

TABLE 4.—*Experimental Data*

Dog	Length of Life in Days	
43	13	Fourteen dogs underwent drainage of the thoracic ducts 24 hours after construction of 15 cm. high jejunal isolated loops. The average length of life was 3.8 days.
44	6	
45	4	
46	3	
47	2	
48	4	
49	2	
50	3	
51	4	
52	2	
53	2	
54	2	
55	2	
56	4	

had any previous attacks of abdominal pain. There was no history suggestive of gallbladder disease or ulcer. He had had "typhoid fever" several years before.

Onset occurred five days before entrance, with severe general abdominal pain, cramping in character, followed in a few hours by vomiting. The pain, which had been constant, had never localized. Vomiting had been persistent so that he had been able to retain nothing. He had taken calomel from time to time without results. There was a small stool the night before entrance, following an enema.

Examination.—The patient was well developed and well nourished. He complained of severe abdominal pain. The facial expression was that of a very sick person. Pain was relieved somewhat by flexing the thighs on the abdomen which was slightly distended. There was no visible peristalsis, but a boardlike rigidity everywhere, with general acute tenderness. There was no local tenderness and no palpable masses were noted. Examination of head, thorax and extremities was negative. The temperature was 97.4 F.; pulse, 104; respirations, 30; white blood count, 7,800; urine, negative.

A diagnosis of acute general peritonitis was made and an exploratory laparotomy was decided on.

Operation (Dr. L. L. Heid).—Under procain anesthesia supplemented by gas-oxygen, the abdomen was opened through the right lower rectus. The abdomen was filled with free pus coming from all portions. No fibrin was seen. A large gangrenous appendix was removed, and cigaret drains were placed in the pelvis and the cecal fossa. Rapid closure was made with through and through silkworm gut sutures. Unfortunately, no culture was taken. The pathologic diagnosis (Dr. Schery) was purulent appendicitis.

Course.—The patient was returned to the ward in a critical condition, and peritonitis treatment was instituted. Fluid was given by hypodermoclysis and rectal drip. Morphin was employed freely and nothing was given by mouth.

May 7: The patient presented an extremely grave appearance. His facies was of the hippocratic type, and he was distinctly euphoric. The skin was covered with large drops of sweat. The temperature was 99.2 F.; pulse, 112; respiration, 20. The abdomen was slightly distended and tender everywhere, with marked rigidity. The pulse was full and bounding.

Second Operation (May 7, E. P. L.).—Under procain anesthesia, a 3 inch (7.5 cm.) incision was made along the posterior border of the left sternocleidomastoid muscle at the lower end. The dissection was carried down to the subclavian vein with retraction of the muscle forward. The thoracic duct was isolated, ligated and opened longitudinally below the ligature for a distance of 1 cm. A small slip of rubber dam was inserted to a distance of 1 cm. below the opening. The wound was packed with gauze and partially closed. Culture taken from the escaping fluid showed no growth.

Postoperative Data.—May 8: There was marked change in the patient's general appearance. The facies had now lost the hippocratic appearance. The patient looked worn and exhausted. He was depressed, as opposed to his euphoria of yesterday. The abdomen was soft, not distended, nor tender, except in the immediate vicinity of the wound, from which there was a slight foul discharge. Culture from the abdominal wound showed no growth. The neck wound was clean and draining large quantities of lymph. The temperature was 100 F.; pulse 130; respiration, 16. The pulse was running and thready. The white blood count was 13,900. The routine treatment of peritonitis was continued.

May 9: The general condition was improved. The neck wound was draining freely, and abdominal drainage had increased. The abdomen was soft and not tender. Gas was passed per rectum. There was no vomiting. The temperature was 98.6 F.; pulse, 120; respiration, 16. Water, given by mouth was tolerated.

May 10: The general condition was about the same, and the wounds were as before. The temperature was 98 F.; pulse, 112; respiration, 24; white blood count, 12,800. The patient looked exhausted. A culture from the abdominal wound showed streptococcus and a gas-producing anaerobe. Liquid diet in small amounts was tolerated.

May 11: The patient was better. The temperature was 98 F.; pulse, 112; respiration, 22; white blood count, 11,800. Drainage from the wound in the neck was decreasing. Peristalsis was active. Stools and gas were passed by enema. There was no vomiting. The patient said that he felt well. He was taking liquid diet.

May 12: The temperature was 98 F.; pulse, 96; respiration, 88. The character of the pulse was much improved. Drainage from the neck was slight. The drain was taken out. The abdomen was still soft and not tender. The abdominal drains were partly withdrawn. A third culture from the abdominal wound yielded *B. paratyphosus* B; *Bacillus coli;* gram-positive bacillus belonging to the perfringens group; streptococcus (Dr. Schery).

From this date on, the course was downhill, with rising pulse and temperature. Abdominal pain began on May 14, with vomiting. There was fulness in the lower abdomen, with tenderness. There was no visible peristalsis or distention. The abdomen was soft. Tenderness in the Douglas pouch was elicited by rectum. There was no bulging. A diagnosis of pelvic abscess was made, May 15, and the wound was explored with the finger under aseptic precautions. Two pockets of pus in the pelvis were opened and drained.

There was no relief of the septic condition. Death ensued May 16, at 8:30 a. m., fifteen days after the onset of appendicitis, ten days after abdominal drainage and nine days after lymphaticostomy.

Necropsy was refused. The abdomen was explored through the wound, and a large abscess was found deep in the pelvis. The upper abdominal peritoneum was injected and dull, with much fibrin but little free pus. Culture from this region showed streptococcus and *B. paratyphosus* B. Death undoubtedly was due to sepsis from the large pelvic abscess.

In certain cases of frank general peritonitis in young adults arising from gangrene of the appendix, recovery will follow treatment of the infecting focus. This patient, however, when seen the day following abdominal drainage, presented an appearance that suggested a fatal outcome within a few hours. In addition to the evidence we possessed that the patient had no resistance to the infection, namely, the absence of temperature and leukocytosis, a glance at the hippocratic facies and the leaking skin aroused immediate alarm.

Following the drainage of the thoracic duct, certain changes in the patient were seen that suggested at the time a favorable effect of the procedure: (1) change of facies from the drawn hippocratic type to the relaxed exhausted type; (2) change in the character of the pulse from the full, bounding septic type to the thin running type; (3) decrease in euphoria; (4) continued improvement in the patient for as long a time as five days, and (5) disappearance of abdominal signs in twenty-four hours.

These observations are, it is seen, entirely matters of personal judgment, in which the opinion of one man might differ from that of another. None of them are subject to quantitative measurement. All except the last might be explained on the assumption that the patient's

toxemia had been relieved. In addition, it is to be noted that his downhill course began when the fistula closed.

This case demonstrates that (1) the creation of a thoracic duct fistula in general peritonitis is not necessarily, in itself, a fatal procedure, and (2) the influence of this proceeding on the course of the disease is possibly a favorable one.

As a result of this study and of an experience with a single clinical case, we must conclude that thoracic duct drainage is sub judice. Theoretically, a reasonable conception, neither experimentation nor our single clinical experience offers proof that it is of real merit. Costain's experimental evidence is open to the criticism that his control "lethal standard" is not necessarily lethal.

SUMMARY

1. Drainage of the thoracic duct in the dog does not exert a favorable influence on general peritonitis.

2. Drainage of the thoracic duct in the dog may exert a slightly favorable influence on the course of toxemia from intestinal obstruction.

3. Clinical observation of a single case of general peritonitis suggests a slightly favorable effect from drainage of the thoracic duct.

TUBERCULOSIS OF JOINTS

A STUDY OF A COMPLETE SPECIMEN

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Some fifteen years ago, I started a study of the pathology of bone and joint tuberculosis, spurred thereto by the great difference of opinion which prevailed in practically all the aspects of the subject of joint tuberculosis in general, its etiology, its pathology, its diagnosis and its treatment, and I had not gone very far before the conclusion was forced upon me that the pathology of the disease rested upon a very insecure footing. Many things which passed as facts, and appeared in standard textbooks, were found on investigation to be based upon the unsupported statement of some eminent clinician, who had been content with the knowledge gained by a naked eye inspection of his specimens. The few writers on the histologic pathology of the disease had not received the attention which they deserved.

From time to time, I made known the results of my observations, but without making much impression. At present, I am compelled to acknowledge that authority has been too much for me. In addition to the influence of authority, the languid interest with which those treating diseases of the joints regard the subject of the pathology of these diseases, must be mentioned as an obstacle. This accounts for the difference of opinion, and the remarkable "cures" which are advocated from time to time. Sound pathology is a prerequisite for the treatment of all diseases of the body, except for the treatment of diseases of the bones and joints. For these, it appears to be unnecessary.[1]

In studying a tuberculous joint in the laboratory, we are usually forced to make sections of small pieces of it, for it is practically impossible to cut, stain and mount a slide of the whole joint. It is rare to get a specimen of uncomplicated tuberculosis of one of the smaller joints, so rare that a thorough description of my specimen is justified.

The specimen was a finger amputated from a young woman, aged 23 years. Four years previous to the amputation, the patient had been under observation in the Stanford clinics, and a diagnosis of tuberculosis of the spine had been made. An ankylosing operation had been urged, and had been rejected. The patient returned in January, 1923, complaining chiefly of pain in her right foot, right forefinger and left wrist. Examination revealed a probable tuberculosis of the proximal inter-

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*From the Laboratory of Surgical Pathology of the Stanford Medical School.

1. I speak of the pathology, not of the pathologic anatomy.

phalangeal joint, a tuberculosis of the tendon sheaths of the forearm, and of the talocalcaneal joint. The patient also had a sluggish ulcer near the tip of the tongue, and her spinal lesion had progressed. Here was evidently a case of multiple involvement occurring in the course of an untreated tuberculosis of a single joint, a true metastasis. A good example of a so-called "focal infection."

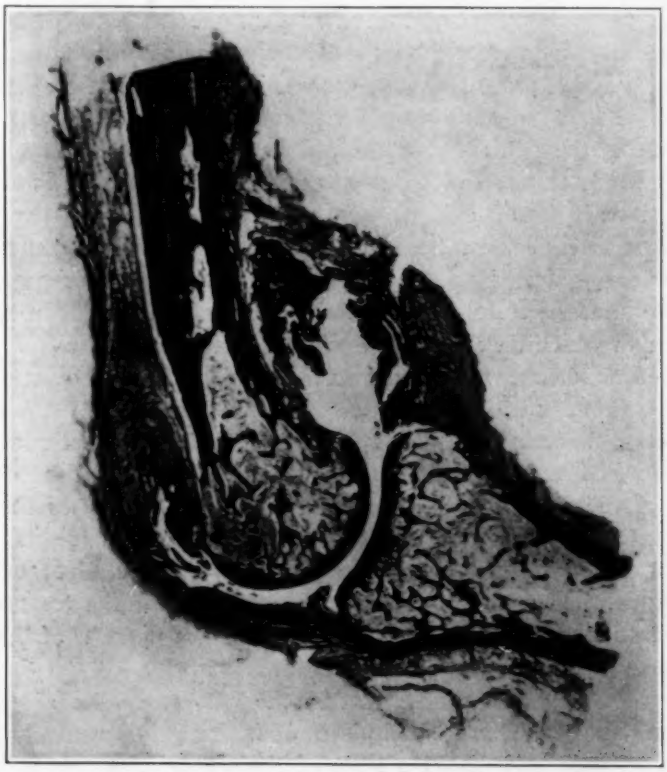

Fig. 1.—Stained slide of sagittal section, somewhat enlarged: extensive involvement of the synovial membrane, with thickening and villous formation; distention of the joint cavity; smooth cartilages, and patchy involvement of the bone marrow, most marked under the side of one cartilage.

As the patient complained mostly of her foot, this was operated on first, together with the tendon sheath in the forearm. Material from the talocalcaneal joint was injected into a guinea-pig, and was found positive for tuberculosis. Both wounds broke down several weeks after operation. The ulcer on the tongue received roentgen-ray treatment. About four weeks after the first operation, the finger was disarticulated at the metacarpophalangeal joint, and an Albee operation was performed on

the spine. These wounds healed by primary intention. Seven weeks after the second operation, the patient died of meningitis. No necropsy was permitted.

The finger was taken to the laboratory, sawn sagitally, fixed in formaldehyd, decalcified in 5 per cent. nitric acid, run up through the alcohols, embedded in paraffin, sectioned, and stained with hematoxylin and

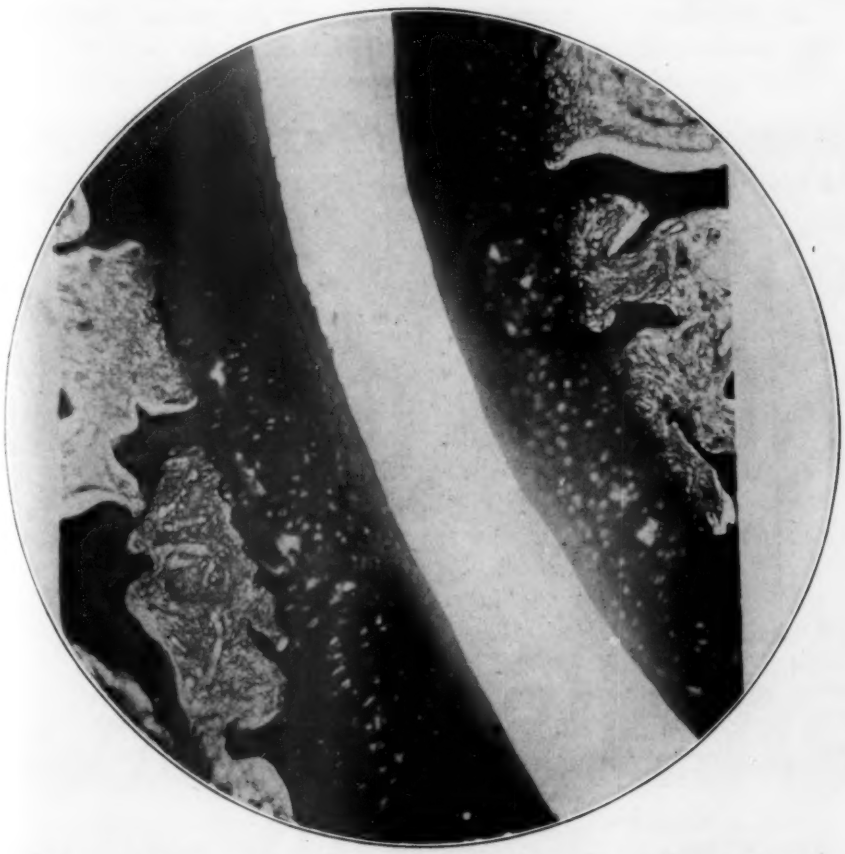

Fig. 2.—Low power photomicrograph of a portion of the slide, showing the smooth cartilages, with invasion of a portion of the subjacent marrow.

with the van Gieson stain. To the naked eye, the synovial membrane appeared thickened, the joint cavity enlarged, and one of the articular cartilages slightly roughened. The bones appeared normal.

HISTOLOGY

Extensive discrete tuberculosis of the synovial membrane was present, with thickening, and a fairly well marked effort at encapsulation of the tubercles, as well as some villous formation. Some of the tubercles showed the beginnings of coagulation necrosis at their center.

The cartilage was slightly roughened at its surface in places, especially near its periphery. Some of the cartilage surface was smooth. The roughness was due to degeneration and fibrillation, and not to any precipitation of fibrin. At the circumference of one articular cartilage, the synovial membrane had encroached upon it, and spread over its surface, adding to its fibrillated appearance.

The bones were involved, but by no means equally or uniformly. One showed a thin, irregular strip of granulation tissue, extending in the marrow, immediately under most of the articular cartilage. No tubercles could be identified in this tissue. The other bone revealed the

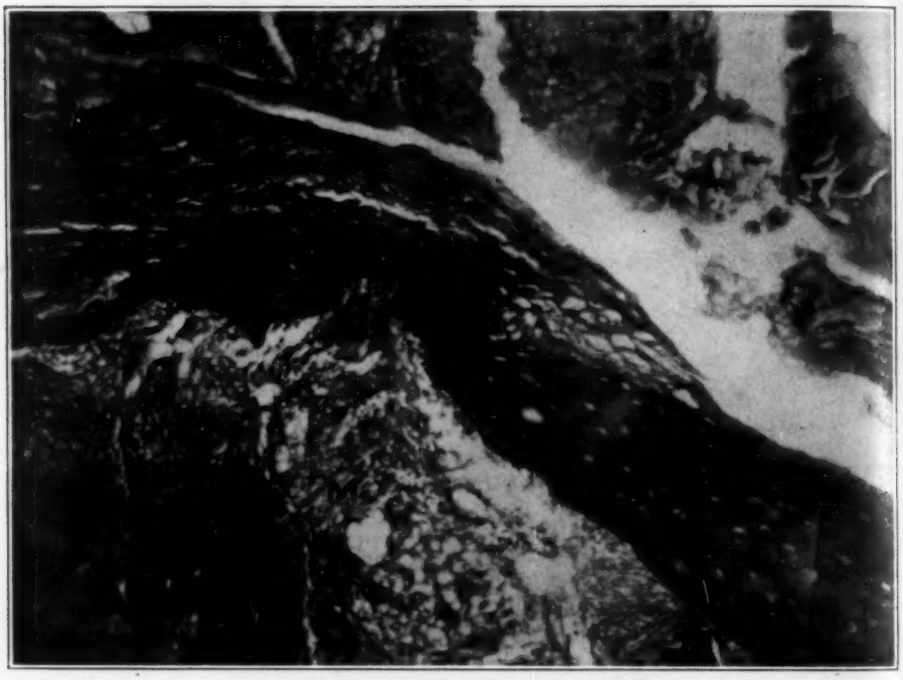

Fig. 3.—Low power photomicrograph, showing the margin of one of the joint cartilages (C): the synovial membrane is spreading in over its surface. Synovial villi (S) cut across. Tuberculous marrow (M), with disappearance of bone trabeculae.

presence of more extensive marrow tuberculosis just beneath the cartilage, but not extending deep into the bone. Most of this tuberculous tissue was at the sides of the section, that is, under the peripheral part of the joint cartilage, and then was much more on one side than on the other.

No dead bone could be distinguished, though in the area of greatest bone involvement, the trabeculae were sparce, and stained rather poorly. There was no evidence of perforation of the cartilage, either from the marrow side or from the joint.

As far as one could judge from the naked eye examination of the specimen and from a study of the stained slides under the microscope, this was a case of primary synovial tuberculosis, in which marrow involvement had begun. The illustrations show clearly the conditions present, which were as follows:

1. Only two tissues were involved directly in the disease, the synovial membrane, and the marrow in the immediate vicinity of the joint. In this specimen, the involvement was mostly synovial.

2. The synovial membrane was thickened, villous, and thrown into folds. Tubercles had formed in its substance. The presence of areas of beginning coagulation as well as of distinct effort at encapsulation indicated that the case was one of medium severity, neither very slow and benign, nor very rapid and destructive in its course.

3. There was no evidence of the precipitation of fibrin either on the surface of the cartilage, or on the synovial membrane. The cartilage was slightly fibrillated at its surface. At its margin, where it shaded into synovial membrane, the latter had begun to encroach upon it, and to take its place, as it were.

4. In the bone, where marrow involvement was present, the bone trabeculae had begun to disappear. They were thin and sparse. Just what the process was by which this had taken place was hard to determine, for there was no sign of the classic rarefying osteitis.

5. The tuberculous process in the bone marrow, together with that in the synovial membrane, communicated at the margin of the cartilage. There was no evidence of perforation of the cartilage. The cartilage, to the naked eye inspection, was almost normal, in spite of the extensive involvement of the synovial membrane; it was only a trifle roughened. In other words, the preponderating involvement of the synovial membrane indicated that the original tubercle was in it, and that the bone marrow became involved by extension under the margin of the articular cartilage.

6. The tuberculous granulations in the marrow were not discrete and regular, but were scattered and irregular in distribution, showing a marked tendency to hug the under surface of the articular cartilage. This is the usual state of affairs, indicating the futility of the proposed operation of removing the disease at an early or late stage. It is, of course, impossible to say how far the granulations have spread in the marrow at any stage. The same may be said of the operation of synovectomy. One can never be positive that the marrow is not involved.

LIVER FUNCTION IN ACUTE INTESTINAL OBSTRUCTION *

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In recent years, the subject of acute intestinal obstruction and its associated toxemia has aroused great interest among surgeons and laboratory investigators. From a clinical standpoint, the necessity for early diagnosis and prompt treatment has been firmly established. From the experimental standpoint, there has been much speculation concerning the nature of the toxemia of acute intestinal obstruction and the relative importance of various factors leading to a fatal outcome. Whipple [1] and his co-workers have shown that acute intestinal obstruction is associated with an increase in the nonprotein nitrogen of the blood, an increase in urinary nitrogen and a depression of renal function. They believe that there is a profound intoxication in acute intestinal obstruction, due to the absorption of a highly toxic proteose from the obstructed intestine. Other workers have emphasized the significance of dehydration of the tissues. Haden and Orr [2] have laid stress on the decrease in blood chlorids, but this contention has been questioned by the work of Copher and Brooks.[3] Werelius [4] has stated that acute intestinal obstruction is associated with marked hepatic insufficiency, as shown by the absence of bile from the duodenum. He claims that death is due to disturbed liver function.

On a hypothetic basis, reasons can be advanced to favor the theory of liver insufficiency. In the systemic absorption of toxic substances from the intestine, the liver, through the portal blood stream, is necessarily the first organ to receive the poisonous products. As a depression of bodily function seems to be one of the prominent symptoms of intestinal obstruction, a similar effect on the liver might theoretically be expected. On the other hand, an increased percentage of urea nitrogen

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1. Whipple, G. H.; Rodenpaugh, F. H., and Kilgore, A. R.: Intestinal Obstruction, J. Exper. Med. **23**:123 (Jan.) 1916.

2. Haden, R. L., and Orr, T. G.: Chemical Changes in the Blood of Man After Acute Intestinal Obstruction, Surg., Gynec. & Obst. **37**:465 (Oct.) 1923.

3. Copher, G. H., and Brooks, Barney: Intestinal Obstruction, Ann. Surg. **78**:755 (Dec.) 1923.

4. Werelius, A.: Is Death in High Intestinal Obstruction Due to Liver Insufficiency? J. A. M. A. **79**:535 (Aug. 12) 1922.

of the blood, as found in intestinal obstruction, by repeated observations, is not encountered in hepatic insufficiency. Furthermore, the deeply colored intestinal contents found in gastric lavage would seem to contradict the statement that bile ceases to flow. Nevertheless, it seems of interest to know precisely how the liver is affected in acute intestinal obstruction, and it was for this purpose that the following studies were undertaken.

The quantitative determination of liver function is, unfortunately, a more difficult problem than the estimation of the activity of other organs. Numerous tests have been suggested, but these have failed almost uniformly. The reasons for failure have apparently been threefold: (1) the large factor of safety in liver function; (2) the difficulty in collecting bile or complete stool specimens, and (3) the interdependence of other organs, such as the pancreas and kidney, in liver activity. In 1909, Abel and Rowntree [5] found that phenoltetrachlorphthalein injected intravenously was excreted in the bile. Rowntree and his co-workers applied the test clinically, determining the amount of phenoltetrachlorphthalein in the feces and finding a decreased percentage in cases of pathologic processes in the liver. Following the introduction of the duodenal tube, experiments were conducted directly on duodenal contents, and apparently better results were obtained than by examination of the feces. In 1922, Rosenthal [6] showed that in hepatic insufficiency there was a retention of phenoltetrachlorphthalein in the serum, and that this could be estimated with a fair degree of accuracy. This technic has been carried out by Rosenthal in a series of experimental and clinical cases. Similar methods have been employed by Rosenfield and Schneiders [7] and other workers, with satisfactory results.

The plan of procedure in our series of animals was to produce an obstruction of the intestine either by ligation or by division of the intestine, and on the following days to perform the phenoltetrachlorphthalein test. At first, the test was performed before the obstruction was created, but, as the animals examined all showed normal values, this preliminary test was later dispensed with. In some animals, the serum was examined fifteen minutes and one hour after injection, but as the dye was rarely found at the end of one hour, subsequent tests were made fifteen and thirty minutes after injection. As it was very difficult to obtain plasma free from hemolysis, determinations were made on serum, which in most instances was clear. In order to obtain suf-

5. Abel and Rowntree: J. Pharmacol. & Exper. Therap. **1**:233, 1909.

6. Rosenthal, S. M.: A New Method for Testing Liver Function with Phenoltetrachlorphthalein, J. A. M. A. **79**:215 (Dec. 23) 1922.

7. Rosenfield, H. H., and Schneiders, E. F.: Improved Phenoltetrachlorphthalein Test for Liver Function, J. A. M. A. **80**:743 (March 17) 1923.

ficient serum for examination, blood was centrifugated after the formation of the clot. By this method, it was possible to obtain sufficient serum from a relatively small specimen of blood, thus eliminating the loss of time encountered in waiting for the spontaneous separation of the serum. Frequent determinations of nonprotein nitrogen of blood were made.

In regard to the secretion of bile, no quantitative studies were made with reference to the amount produced after intestinal obstruction. Indirect evidence was obtained by observations of the character of the duodenal and intestinal contents above the level of the obstruction. The condition of the gallbladder and biliary ducts and the quality of bile were noted carefully at necropsy. In two animals, the common duct was ligated and a biliary fistula created, simultaneously with the production of the intestinal obstruction. In these two animals, there was apparently abundant secretion of bile.

In order to study the question of structural liver changes, sections of liver were taken before and after the production of intestinal obstruction. These sections failed to show any demonstrable histologic alteration. There was no change in the appearance or size of the cells and no evidence of inflammatory or degenerative processes. The gross appearance of the liver at necropsy was uniformly normal.

EXPERIMENTAL WORK

Dog 1 (weight, 11 kg.).—Oct. 26, 1923: Fifty-five milligrams of phenoltetrachlorphthalein was injected intravenously. Specimen of blood serum obtained fifteen minutes later showed no dyestuff.

October 30: The animal was anesthetized with ether for thirty minutes and 55 mg. of dye was then injected. Serum examined fifteen minutes and one hour later showed no dye.

November 9: The animal was anesthetized with ether and the abdominal cavity was opened. A loop of ileum about 75 cm. above the ileocecal junction was ligated with linen tape. A small section of the liver was removed and microscopic examination revealed normal liver tissue. The nonprotein nitrogen was 33.5 mg. per hundred cubic centimeters of blood.

November 11: The dog vomited and was moderately ill. Fifty milligrams of phenoltetrachlorphthalein was injected. Serum examined after fifteen minutes showed 1 per cent. of dye; after one hour, none. The nonprotein nitrogen was 25.5 mg. per hundred cubic centimeters.

November 12: The animal continued to vomit. Fifty milligrams of dye was injected. Serum after fifteen minutes showed 1 per cent. of dye; after one hour, none. The nonprotein nitrogen was 46.0 mg. per hundred cubic centimeters.

November 14: The dog was moribund. Forty-five milligrams of dye was injected. Serum examined after fifteen minutes showed 3 per cent. of dye; after one hour, none. The nonprotein nitrogen was 71 mg. per hundred cubic centimeters. The dog was then killed with ether. The necropsy showed an obstruction of the intestine at the midpoint of the ileum. Above this level, the intestine was dilated; below this level, it was collapsed. The liver and kidneys

appeared normal in the gross. The gallbladder was distended with bile of normal appearance. The contents of the stomach and the obstructed intestine were greenish. Microscopic examination of the liver revealed normal tissue with no evidence of inflammation or degenerative changes. Examination of sections of the kidney revealed that a few glomeruli were adherent to the capsule, but there were no inflammatory changes.

Dog 2 (weight 8.5 kg.).—Oct. 26, 1923: Forty-three milligrams of phenoltetrachlorphthalein was injected intravenously. The blood serum examined fifteen minutes later showed no dye.

November 7: The animal was anethetized with ether and the abdominal cavity was opened through a right rectus incision. One of the loops of the jejunum was ligated with a strip of linen tape.

November 9: The dog vomited a few times but was not prostrated. Forty milligrams of dye was injected and no dyestuff was recovered in the blood serum, in samples removed fifteen minutes and one hour later. The nonprotein nitrogen was 31.0 mg. per hundred cubic centimeters.

November 11: The dog was quite ill and lay quietly in the cage. Forty milligrams of dye was injected. Serum at the end of fifteen minutes showed 0.5 per cent. of dye; at end of one hour, none. The nonprotein nitrogen was 42.2 mg. per hundred cubic centimeters.

November 12: The dog was much brighter. There were two bowel movements during the night.

November 13: The animal was anesthetized with ether. The abdominal cavity was opened, and it was found that the tape had cut through the intestine and that a partial anastomosis had taken place. This loop of intestine was resected and the stumps of the intestine were inverted with a pursestring suture.

November 14: The dog died during the night. Necropsy revealed that the peritoneal cavity was free from fluid and exudate. The upper jejunum was divided, with ends inverted. The stomach and duodenum were greatly distended with bile-stained fluid material. The gallbladder was distended with normal appearing bile.

Dog 3 (weight, 12 kg.).—Nov. 14: Sixty milligrams of phenoltetrachlorphthalein was injected. At the end of fifteen minutes, there was a very slight trace of dye in the blood serum; at the end of one hour, none. The nonprotein nitrogen was 22.0 mg. The animal was anesthetized with ether and the abdominal cavity was opened. The ileum was divided about 18 cm. above the cecum and the ends were inverted with pursestring suture.

November 16: The dog was very ill, vomiting repeatedly. Fifty milligrams of dye was injected. At the end of fifteen minutes, there was 7 per cent. of dye present; at the end of one hour, 2 per cent. The nonprotein nitrogen was 72.0 mg.

November 17: The dog had died during the night. The necropsy showed the peritoneal cavity free from fluid and exudate. There was marked distention of stomach and intestine, above the level of division. The liver appeared normal. The gallbladder was distended.

Dog 4 (weight, 13 kg.).—Nov. 16: The animal was anesthetized with ether, the abdominal cavity opened, and the lower ileum divided. The ends were inverted by a pursestring suture. A section of liver, removed at time of operation, was normal on microscopic examination. The nonprotein nitrogen was 32.9 mg.

November 17: Sixty milligrams of dye was injected. At the end of fifteen minutes, 2 per cent. of dye was present in the serum; after one hour, 0.5 per cent. The nonprotein nitrogen was 34.0 mg.

November 18: Fifty-five milligrams of dye was injected. After fifteen minutes, the serum showed a faint trace of the dye. The nonprotein nitrogen was 26.0 mg.

November 19: Fifty milligrams of dye was injected. A forty-five minute sample showed no dye. The nonprotein nitrogen was 28.5 mg.

November 20: Forty-five milligrams of dye was injected. The specimens were hemolyzed, and no readings could be obtained.

November 21: The dog died during the night. Necropsy showed that the stomach and the intestine above the site of division were distended. There was no free fluid in the peritoneal cavity. The liver and kidneys appeared normal. The gallbladder was distended with dark green bile. Microscopic examination of sections of the liver showed no pathologic changes.

Dog 5 (weight, 7 kg.).—Nov. 19, 1923: Thirty-five milligrams of phenoltetrachlorphthalein was injected. The serum, at the end of forty-five minutes, showed no dye present. The nonprotein nitrogen was 24 mg. The animal was anesthetized with ether and the lower ileum ligated with linen tape. A section of the liver showed normal tissue.

November 21: The dog was listless, and vomited several times. Thirty milligrams of dye was injected. The serum at end of fifteen minutes showed 3 per cent. of dye; after thirty minutes, 1 per cent. The nonprotein nitrogen was 38.7 mg.

November 24: The dog was very ill. Thirty milligrams of dye was injected. The serum, after fifteen minutes, showed 3 per cent. of dye; after thirty minutes, 1 per cent. The nonprotein nitrogen was 40.8 mg.

November 26: The dog was moribund, although it had had two bowel movements in the last twenty-four hours. The animal was anesthetized with ether and necropsy performed. The peritoneal cavity contained a small amount of purulent exudate. At the site of the tape, the intestine was partly cut through, with a partial anastomosis of the intestine. The intestine above the tape was greatly distended and contained a large amount of bile-stained fluid. The gallbladder was distended with bile of normal appearance. The liver was normal on both gross and microscopic examination.

Dog 6 (weight, 6.7 kg.).—Nov. 26, 1923: The animal was anesthetized with ether and the abdominal cavity opened. The ileum was divided 6 cm. above the ileocecal junction, and the ends inverted by a pursestring suture.

November 27: Thirty milligrams of dye was injected. The serum after fifteen minutes showed 1 per cent. of dye; after thirty minutes, none. The nonprotein nitrogen was 20.9 mg.

November 28: The dog was quite ill, vomiting repeatedly. Thirty milligrams of dye was injected. The serum, after fifteen minutes, showed 4 per cent. of dye; after thirty minutes, 1 per cent. The nonprotein nitrogen was 30.1 mg.

November 30: The dog died during the night. Necropsy showed the stomach and intestine greatly distended above the site of division. The peritoneal cavity contained no exudate. The gallbladder was distended with bile. The liver and kidneys appeared normal on gross examination.

Dog 7 (weight, 5.5 kg.).—Nov. 26, 1923: The animal was anesthetized with ether and the ileum divided about 6 cm. above the ileocecal junction. The ends were inverted with a pursestring suture.

November 27: Twenty-five milligrams of phenoltetrachlorphthalein was injected. The serum, after fifteen minutes, showed 5 per cent. of dye present; after thirty minutes, 1 per cent. The nonprotein nitrogen was 27 mg.

November 28: Twenty-five milligrams of dye was injected. The serum, after fifteen minutes, showed 5 per cent of dye; after thirty minutes, 4 per. cent. The nonprotein nitrogen was 27.0 mg.

November 30: Twenty-five milligrams of dye was injected. The serum, after twenty minutes, showed 2 per cent. of dye; after forty minutes, none. The nonprotein nitrogen was 26.0 mg. As the dog was very ill, it was anesthetized and necropsy performed. The peritoneum was smooth and glistening. The stomach and intestines above the site of division were distended and contained bile stained watery material. The liver and kidneys appeared normal. The gallbladder was distended with bile. Microscopic examination of sections of the liver revealed no pathologic changes.

Dog 8 (weight, 6.7.)—Dec. 3, 1923: The animal was anesthetized with ether and the abdominal cavity was opened. The common bile duct was ligated and divided. The ileum was divided about 12 cm. above the ileocecal junction, and the ends were inverted by pursestring suture. The gallbladder was sutured to the skin and then incised, a fistula being created.

December 4: The dressings were copiously stained with bile. Thirty milligrams of dye was injected. The blood serum, after fifteen minutes, showed 2 per cent.; after thirty minutes, 1 per cent. The nonprotein nitrogen was 25.0 mg.

December 5: The dog had vomited twice. Thirty milligrams of dye was injected. The serum, examined thirty minutes after injection, showed no dye. The nonprotein nitrogen was 38.4 mg.

December 6: Thirty milligrams of dye was injected. The serum, after twenty-five minutes, showed 2 per cent. of dye; after forty minutes, none. Nonprotein nitrogen was 28.9 mg.

December 7: The dressings continued to be saturated with bile. Thirty milligrams of dye was injected. The serum, after fifteen minutes, showed no dye; after thirty minutes, none. The nonprotein nitrogen was 27.4 mg.

December 12: The dog died during the night. Up to the time of death, the dressings were constantly bile stained. Necropsy revealed a biliary fistula leading to the gallbladder. The common duct was found divided and collapsed. The peritoneal cavity contained a large amount of purulent fluid. The divided ends of the intestine were found with difficulty because of the many adhesions.

Dog 9 (weight, 7.2 kg.)—Dec. 3, 1923: The animal was anesthetized with ether and the abdominal cavity was opened. The common duct was ligated and divided. The ileum was divided just above the ileocecal junction. The ends were inverted with a pursestring suture. The gallbladder was sutured to the skin.

December 4: The dog vomited. The dressings were saturated with bile.

December 5: Thirty-five milligrams of dye was injected intravenously. The serum, examined after fifteen minutes and after thirty minutes, showed no dye. The nonprotein nitrogen was 41.3 mg.

December 6: The dog was very ill and vomited frequently. The dressings were soaked with bile. Thirty-five milligrams of dye was injected. Specimens taken twenty and thirty minutes later showed no dye. The nonprotein nitrogen was 36.5 mg. The dog was then anesthetized and necropsy performed. The intestine was found divided just above the ileocecal junction. The intestine above this level was moderately distended. There was no free fluid in the peritoneal cavity.

Dog 10 (weight, 12.4 kg.).—Dec. 17, 1923: The animal was anesthetized with ether and the abdominal cavity was opened. The fourth portion of the duodenum was ligated with linen tape.

December 18: The dog vomited several times. Sixty milligrams of dye was injected. The serum at the end of thirty minutes showed 1 per cent.; at the end of forty-five minutes, none. The nonprotein nitrogen was 32.9 mg.

Dec. 19: The dog continued to vimit frequently. Fifty-five milligrams of dye was injected. At the end of fifteen minutes, the serum showed 1 per cent.; at the end of thirty minutes, none.

December 22: The dog was moribund. Fifty milligrams of dye was injected. The results were the same as those found three days previously. The nonprotein nitrogen was 25.9 mg. The dog was anesthetized and necropsy performed. There was no fluid or exudate in the peritoneal cavity. The stomach and duodenum were greatly distended. The liver and kidneys were normal. The gallbladder was distended with bile. The liver was normal on microscopic examination.

Dog 11 (weight, 8.7 kg.).—Dec. 17, 1923: The dog was anesthetized with ether and the abdomen was opened. The fourth portion of the duodenum was ligated with tape.

December 18: The dog vomited and was moderately prostrated. Forty milligrams of dye was injected. At the end of fifteen minutes, there was 1 per cent. of dye; at the end of thirty minutes, none. The nonprotein nitrogen was 30.1 mg.

December 19: The dog died during the night. There was no fluid in the peritoneal cavity. The stomach and duodenum were distended and contained a large amount of greenish fluid. The liver was normal on both gross and microscopic examination.

Dog 12 (weight, 13.3 kg.)—Jan. 7, 1924: The animal was anesthetized with ether. The upper jejunum just below the ligament of Treitz was divided, and the ends were inverted.

January 8: The dog was quite ill. Sixty-five milligrams of dye was injected. The serum, after fifteen minutes, showed 1 per cent. of dye; after thirty minutes, none.

January 9: The dog was vomiting frequently. Sixty milligrams of dye was injected. The serum, examined after fifteen minutes, showed 1 per cent. of dye; after thirty minutes, none. The nonprotein nitrogen of the blood was 42.2 mg. per hundred cubic centimeters.

January 10: The dog was greatly prostrated. Sixty milligrams of dye was injected. The serum, after fifteen minutes, showed a faint trace of dye; after thirty minutes, none. The nonprotein nitrogen was 48.7 mg.

January 11: The dog was in an agonal condition. Fifty-five milligrams of dye was injected. The serum, after twenty minutes, showed 1 per cent. of dye; after forty minutes, none. The nonprotein nitrogen was 50.0 mg. The dog was then anesthetized and necropsy performed. The stomach and duodenum were distended and contained large amounts of greenish fluid. The gallblader was distended with bile. The liver and kidney appeared normal both on gross and on microscopic examination.

Dog 13 (weight, 13.7 kg.).—Jan. 7, 1924: The animal was anesthetized with ether. The fourth portion of the duodenum was divided and the ends were inverted with pursestring suture. The nonprotein nitrogen was 28.8 mg.

January 8: The dog was vomiting continuously. Sixty-five milligrams of dye was injected. The serum, after fifteen minutes, showed a very faint trace of dye; after thirty minutes, none. The nonprotein nitrogen was 42.2 mg.

January 9: The dog was moribund. Sixty milligrams of dye was injected. The serum, after thirty minutes, showed 1 per cent. of dye. The nonprotein

nitrogen was 74.0 mg. The dog was killed with ether. Necropsy showed that the fourth portion of the duodenum was divided, with the ends well inverted. The stomach was moderately distended with greenish fluid. The gallbladder was distended with bile which appeared normal. The liver showed no pathologic changes on either gross or miscroscopic examination.

Experimental Data

Number	Site of Obstruction	Phenoltetrachlorphthalein Readings Per Cent. 15 Min.	30 Min.	1 Hour
1	Ileum	1—3		None
2	Jejunum	0—0.5		None
3	Ileum	7		2.0 per cent.
4	Ileum	Very faint trace	2	0.5 per cent.
5	Ileum	3	1	
6	Ileum	1—4	0—1	
7	Ileum	2—5	2—4	
8	Ileum	0—2	0	
9	Ileum	0	0	
10	Duodenum	1	0	
11	Duodenum	1	0	
12	Duodenum	1	0	
13	Duodenum	Very faint trace	0	

SUMMARY

1. The phenoltetrachlorphthalein test was performed in a series of thirteen dogs in which some portion of the small intestine had been obstructed. The results showed a slight degree of retention, the average reading varying between 1 and 3 per cent. at the end of fifteen minutes. In one dog, there was a 7 per cent. retention.

2. Necropsy showed that the gallbladder was uniformly distended with bile of normal appearance.

3. The contents of the intestine above the level of the obstruction were stained with bile.

4. In two dogs, in whom a biliary fistula was created simultaneously with the production of the intestinal obstruction, there was no apparent decrease in the drainage of bile, even when the animals were moribund.

5. Necropsy showed no gross change in the liver.

6. Histologic examination of sections of the liver removed at necropsy revealed no structural changes.

CONCLUSIONS

Liver function as determined by the phenoltetrachlorphthalein test and the production of bile is apparently not greatly disturbed in acute intestinal obstruction.

There are no structural changes in the liver associated with acute intestinal obstruction.

INJURIES TO CARPAL BONES: FRACTURE OF THE SCAPHOID AND DISLOCATION OF THE SEMILUNAR*

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The object of this paper is to keep before the medical profession the fact that injuries to the bones of the wrist are a real and not an uncommon occurrence. Codman and Chase [1] have done a classic work on this subject, which has recently been followed by Todd's exhaustive treatise.

As the roentgen ray is being perfected so that in a short time it will be part of every progressive physician's equipment, it will be well to remember that every roentgenogram of a possible Colles' fracture or "sprained wrist" should also be examined for injuries to the carpal bones. This does not mean that a Colles' fracture and injuries to the carpal bones occur together, but that there are many wrist injuries not showing a Colles' fracture which undoubtedly have a fracture or dislocation of the carpal bones, instead of a bad sprain.

When roentgen rays are more commonly employed, a so-called bad sprained wrist will be a curiosity.

Undoubtedly, many conscientious physicians here believe the result obtained in a bad Colles' fracture to be poor, when, as a matter of fact, the trouble lay in the carpal bones.

Perhaps one might ask why we do not hear of malpractice suits in this connection, because of such injuries being overlooked. This might be explained by Preiser,[2] who shows that an injury to the wrist may be followed by a central absorption process going on in the fractured bone, a so-called rarefying osteitis. A bone thus weakened may subsequently undergo pathologic disintegration. He suggests that the area of increased transradiancy seen in his roentgenograms is due to the absorption of the bone, caused by the rupture of the nutrient blood vessel. In a few cases, in which the bone was excised a few days after the fracture and carefully sectioned, it was found that the center of the bone was occupied by a recent clot and liquid blood; in other cases, cystic degeneration was described and was attributed to osteitis fibrosa following the injury.

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* Read before the Fourth District Branch of the New York State Medical Society, Oct. 12, 1923, Lake Placid, N. Y.

1. Codman and Chase: Ann. Surg., 1905, p. 325.
2. Preiser: Zentralbl. f. Chir., Leipzig **33**, 1910.

Clinically, if a fracture remains ununited, the permanent disability is so great that it not only seriously interferes with the comfort of the patient, but also, in the case of a working man, limits his working capacity and his ability to earn his living.

Not wishing to describe the unusual injuries to the carpal bones, I will confine my remarks to the fracture of the scaphoid and the dislocation of the semilunar, which may occur together or separately.

FRACTURE OF SCAPHOID

Anatomy (Gray [3]).—The scaphoid, or navicular bone, is the largest bone of the first row and is contiguous to the radius. It received its name from its fancied resemblance to a boat, being broad at one end and narrow, like a prow, at the opposite end. It has six surfaces with five articulations: radius above, trapezium and trapezoid below, os magnum and semilunar internally.

Mechanism.—Why is the scaphoid fractured more often than the seven other carpals combined? A study of the bones reveals the mechanism. The scaphoid lies interposed between the lower end of the radius and the distal row of the carpal bones. Its position in relation to the distal row as well as to the radius depends on the position of the hand. In radial flexion of the hand, the scaphoid comes to lie between the lower end of the radius and the os magnum. Force, transmitted upward from the palm of the hand, will jam the scaphoid between the os magnum and the radius, both of which are more solid in their structure than the scaphoid itself. Furthermore, the concave surface of the scaphoid receives the os magnum like a wedge, and this wedge action breaks the scaphoid when exerted at the weakest spot of the latter, which has a concave middle. Force, transmitted downward from the radius, acts in exactly the same way, making the scaphoid a buffer in both types of injuries.

According to the principles of stress and strain, the scaphoid is fractured at different angles, in various injuries.

Occurrence.—Fractures of the scaphoid occur, similar to Colles' fracture. The main point to remember in the case of a fracture of the scaphoid is the fact that it is due to great violence. A simple slip on the sidewalk very seldom causes such a fracture. It usually happens when one falls from a great height or receives some force concentrated over a small area, such as the back-firing of an automobile, or a blow from a flying piece of steel.

In analyzing the fracture work in the office of Drs. McMullen, Lenz and myself for two years (1921 and 1922), which included 314

3. Gray's Anatomy, Ed. 18, 1910, p. 196.

fractures of all kinds, I found four cases of injuries to carpal bones, constituting more than 1.2 per cent. of all fractures. The late J. B. Murphy [4] states that the percentage of carpal bone injuries is much higher than 4.

According to the literature, the percentage of diagnosis of carpal bone injuries would seem to be an index of the efficiency of the roentgenologist. There is no doubt, in my mind, that the percentage of fractures of the wrist bones is very much higher than reported;

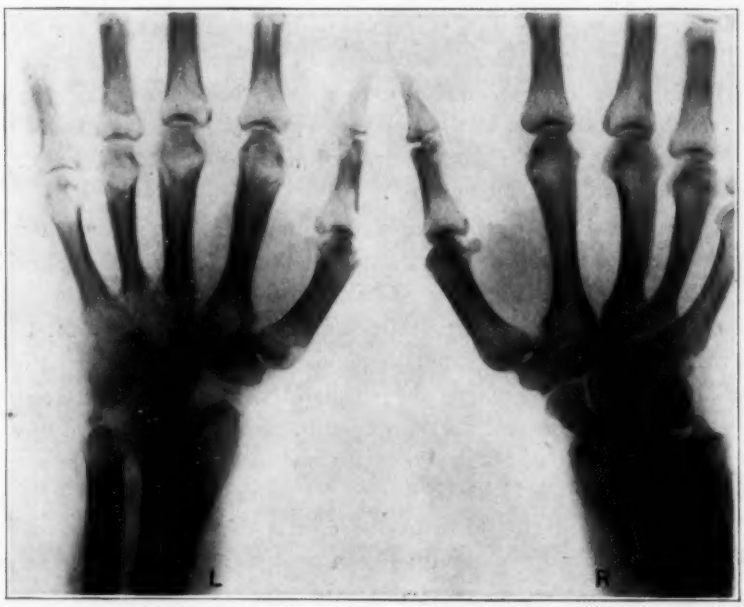

Fig. 1.—Left: Fracture of scaphoid after removal of fragment. Right: Normal wrist.

unfortunately, we do not see all of them, as the coroner often takes charge of the case.

There must be a very high percentage in the aviation service, but, up to date, I have seen very little reference to this phase of the subject in the literature. Of course, we, as clinicians, are not interested in the outcome of the "aviator's fracture," but it is a fertile field for the statistician.

Symptoms.—The patient gives the history of an injury of a serious nature. There is marked pain and swelling over the back of the hand, which is held rigid. There is severe pain on flexion or extension of the wrist. If seen within a few days after injury there is usually no

4. Murphy, J. B.: Chicago Clinics, 1915.

attempt to use the wrist. This condition simulates a tuberculous lesion of the wrist, because of intense pain on motion.

Diagnosis.—A fracture of the scaphoid itself is not so easily diagnosed as a combined dislocated semilunar and fracture of the scaphoid, which is more common. However, certain points should be noted in fracture of the scaphoid.

There is the history of a severe injury, such as a bad fall, or a sudden blow of great force on the hand.

There is a marked swelling over the base of the thumb. The swelling is substyloid as compared with a Colles' fracture.

The point of maximum tenderness is over the depression at the base of the thumb on the outer side of the carpus, between the extensor pollicis longus on the one side and the extensor pollicis brevis and the abductor pollicis longus on the other side. In examining this depression to determine the presence of a scaphoid fracture it is best to have the patient's hand held in ulnar flexion, because that position brings the scaphoid out between the os magnum and radius, and into the depression.

Another point considered diagnostic is the Vaughan [5] test, which consists of holding the patient's wrist, flexing the fingers and gently tapping the third metacarpal bone. This causes much pain.

I have found crepitus in two cases. It was not noted in the old injuries. Todd [6] and others claim there is no crepitus on examination.

One should study the roentgenogram carefully before making a diagnosis.

A practical way to obtain a good roentgenogram of a scaphoid is to place the two wrists in abduction, with the tube in a position over the midline between the two hands, as far forward as the length of the knuckle.

Treatment.—In fracture of the scaphoid, the fragments should be manipulated under a fluoroscope in order to put the fragments in a better position. Then they should be put in a cockup splint for ten days, and massage and electrical treatments started as soon as the swelling has subsided, which usually occurs after four or five days. Passive motion should be started about the ninth or tenth day after injury. If there is any reaction, such as pain or swelling, treatment should be stopped for a few days. The patient should be encouraged to use his hand as much as possible after ten days. Whenever pain ensues, exercise should be limited. If, after four or five weeks, there is no improvement in the condition, a roentgenogram should be made, to determine whether there are arthritic changes. If so, it is well to remove the bone. The Germans advise immediate removal. It seems

5. Vaughan: Chicago Clinics, 1915.
6. Todd, A. H.: Brit. J. Surg. **9**:7 (July) 1921.

better judgment to give the bone a chance to unite, but, in the event of a failure, we should not wait until marked arthritic changes have developed, and expect surgery to do much good.

DISLOCATION OF THE SEMILUNAR

Another common injury to the carpal bone is dislocation of the semilunar.

Anatomy.—The semilunar bone (half-moon shape) may be distinguished by its deep concavity and its crescentic outline. It is situated in the center of the upper row of carpus bones, between the scaphoid

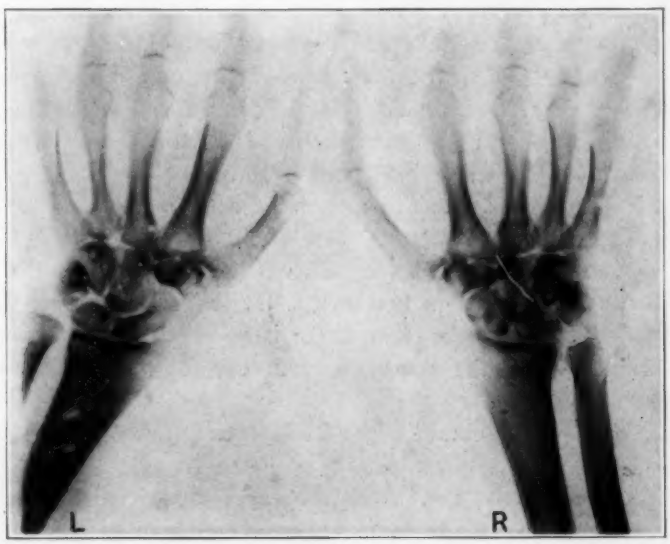

Fig. 2.—Left: Normal wrist. Right: Fracture of scaphoid and dislocation of semilunar.

and the cuneiform. The superior surface is convex, smooth and bounded by four edges, articulating with the radius. The inferior surface is deeply concave and of greater extent anteroposteriorly than transversely. It articulates with the head of the os magnum and, by a long, narrow facet, with the unciforme. The palmar and dorsal surfaces are rough, for the attachment of the ligaments, the former being broader and somewhat rounded. The external surface presents a narrow flattened semilunar facet for articulation with the scaphoid. The internal surface is marked by a smooth quadrilateral facet for articulation with the cuneiform. In all, it articulates with five bones, the radius above, the os magnum and unciforme below and the scaphoid and cuneiform on either side.

Causes of injury are similar to those which contribute to a fracture of the scaphoid, such as the back firing of gas engines, a blow on the hand by a piece of machinery at an industrial plant or a fall from a great height.

Mechanism.—Just why a dislocation of a semilunar rather than a fracture of the scaphoid should occur depends on the location of the force and the position of the hand at the time of its application. As a matter of fact, it is not a dislocation of the semilunar forward, but a dislocation backward of the whole wrist. The semilunar is attached by strong ligaments, anteriorly and posteriorly, to both radius and ulna, as well as attached to the other carpal bones. The other bones are

Fig. 3.—Lateral view of bones shown in Figure 2.

attached singly to either the radius or ulna, and to the other carpal bones. Furthermore, the semilunar bone has a shape peculiar to its location. The lower surface is concave and is in contact with the convex surface of the os magnum. The lateral facets just touch the scaphoid and cuneiform on either side, so there is no overlapping of the posterior surface to hinder it from gliding out of its natural position.

Occurrence.—In examining four cases, there were three combined dislocations of the semilunar and fractured scaphoid, with one simple dislocation of the semilunar.

Symptoms.—The symptoms are more pronounced than those of Colles' fracture. The pain is extreme, and the patient holds his fingers semiflexed giving his hand the appearance of a claw hammer. He is afraid to move his fingers because of the pain caused by the spasm

of the flexor tendons. There is the usual numbness and tingling over the first and second fingers due to pressure on the median nerve.

Diagnosis.—Dislocation of the semilunar per se, or, what is more common, fracture of the scaphoid combined with dislocation of the semilunar, should be diagnosed from across the room.

If there is a history of a severe injury, such as a fall from a height, the patient complains of pain in the wrist; one notes a spasm of the flexor tendons, and the wrist anteroposteriorly appears to be twice its size.

Fig. 4 (Case 3).—Left: Dislocation of semilunar before reduction. Right: after reduction.

On closer observation, a marked soft edema is noted over the base of the thumb. The swelling is confined to the wrist; that is, it is substyloid as contrasted with the usual Colles' swelling. However, one should always rule out a Colles' fracture. This can be done easily by putting the index fingers at the styloid process of the radius and ulna, and noting that, normally, the styloid radius is on a lower plane than the styloid of the ulna. Usually, the swelling is confined to the anterior surface, and the hand looks shorter than normal. The dislocated semilunar bone is easily felt on the anterior surface of the wrist, but it is often so tender that little examination will be allowed. The roentgen rays are not needed to make a reasonable diagnosis.

However, the roentgen rays, employed anteroposteriorly and laterally, will, when carefully studied, insure a positive diagnosis.

Treatment.—If the case is diagnosed within the first twenty-four hours, there should be no trouble with reduction.

The literature is full of different methods and treatises on mechanics regarding the reduction of the dislocation. Murphy, Todd [6] and others say that the hand should be hyperextended. Knapp [7] says that it should be done in palmar flexion with open reduction, with the Doris skid. However, in two cases which I diagnosed immediately, the hand was acutely flexed and direct pressure exerted over the dislocated semilunar, which could be easily felt. The result was immediate reduction. No impairment of function followed such reduction. The whole crux of the situation, especially in the case of a semilunar dislocation, is immediate diagnosis. If diagnosis is not made for several weeks after the injury, and there is marked disability and pain, the semilunar bone should be removed. The removal of the semilunar causes slight weakness of the hand, but there is no further pain. This technic of flexing the hand with direct pressure over the prominence will reduce the usual dislocation of the semilunar; that is, if the concave surface is facing the front of the hand or is tilted 90 per cent., so that it is resting on the flexor tendons with its concave surface upward. If it has been manipulated previously, and twisted around at an angle of more than 90 per cent., I feel that it would be useless to manipulate, even with the aid of the fluoroscope. If possible, it is advisable to have a fluoroscope at hand before manipulation is started.

CONCLUSIONS

1. All bad sprains or poor results from Colles' fracture should be examined by roentgen ray for carpal injuries.

2. Early diagnosis and treatment, particularly as applied to a dislocated semilunar, result in a useful hand. Late diagnosis, even with treatment, means a markedly impaired member.

3. The patient should be anesthetized before manipulation of the hand.

4. Manipulation should be done under the fluoroscope whenever possible.

5. In case of late diagnosis, one should not hesitate to remove both parts of the fractured scaphoid, as well as the dislocated semilunar.

6. Early massage and passive movements, given as soon as the pain and swelling subside, are essential.

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7. Knapp, H. B.: Dislocation of Semilunar Carpal Bone, J. A. M. A. **79:** 1992 (Dec. 9) 1922.

REPORT OF CASES

CASE 1.—J. T., a mechanical engineer, aged 40, Jan. 29, 1921, fell from a ladder 25 feet high, striking the pavement and sustaining concussion of the brain, fracture of the pelvis, fracture of the left elbow, Colles' fracture (right), rupture of the spleen and laceration of the ureter (left), for which an exploratory laparotomy was performed. He also sustained an injury to his left wrist, which seemed to show crepitus. The roentgen-ray examination of the wrist was negative. Roentgenograms were taken repeatedly over a period of several weeks, but were still negative.

After a prolonged study of the roentgenograms and a closer clinical observation, a diagnosis of fracture of the scaphoid and dislocation of the semilunar was made.

Fig. 5 (Case 4).—Left: Fracture of scaphoid and dislocation of semilunar after reduction of dislocation and manipulation of scaphoid. Right: Lateral view.

The patient refused to consider an operation on the wrist, but was treated by our masseuse with massage and electrical treatments, for several months.

The scaphoid bone apparently united in a fair position, but the semilunar remained dislocated. He had a prolonged and painful disability, but physiotherapy brought about a marked improvement. At the present time, he has about 25 per cent. use of his hand.

Apparently, he lost confidence in us and consulted surgeons, osteopaths, chiropractors, etc., but no one wants to advise any more treatments. It is a tragedy that the osteopaths apparently have never heard of dislocated semilunars; instead, they talk glibly about dislocated vertebrae, which borders on occultism.

CASE 2.—W. W. S., a mechanic, aged 30, fell downstairs, March 1, 1922, while at work in an industrial plant. He was examined by roentgen ray and a fracture of the styloid process of the right ulna was reported. After being

treated several weeks for ulnar fracture he still complained of pain and loss of the use of his right hand.

April 10, he was sent to our office, where Dr. Lenz made a roentgen-ray diagnosis of fracture of the scaphoid and anterior dislocation of the semilunar.

He had the typical "fat wrist." The fingers were partly flexed, and he had no use of the hand.

A few days later, Dr. McMullen removed a part of the scaphoid bone through a posterior incision. There was apparently little improvement, and a few weeks later the other fragment of the scaphoid, as well as the semilunar, was removed through an anterior incision.

For several weeks he received massage and electrical treatment, and, July 21, he was discharged, with a wrist which had 50 per cent. flexion and extension, with good lateral motion. He could grasp fairly well and close his fist, but he complained of weakness in his wrist whenever he tried to turn a door knob.

CASE 3.—H. C. G., a butcher, aged 40, July 4, 1922, was cranking an automobile, when it back-fired and hurt his wrist. He immediately consulted a doctor nearby, who set the fracture (supposedly a Colles'), and put the arm in splints. On his way home, his arm pained him so much that he came to the office, with the usual fat wrist and fingers in semiflexion. Roentgen-ray examination revealed a dislocated semilunar.

Under a general anesthetic, the hand was flexed, and when pressure was exerted over the prominent semilunar, it slipped into position with a click. I put the hand in a cockup splint for ten days, starting massage and electrical treatments a few days after the accident. In the course of six weeks, the patient returned to his work as a butcher, with no impairment of function.

CASE 4.—F. K., a mechanic, aged 40, while at work, Nov. 2, 1922, at an industrial plant, was struck on the right wrist by a piece of steel. Immediately, the wrist became swollen and tender. It was examined by roentgen ray and a fracture of the scaphoid with a dislocation of the semilunar was diagnosed.

Under an anesthetic, administered at the hospital, I effected a reduction by flexing the wrist and pushing down on the prominent semilunar, which clicked back into position. This was immediately checked up by the roentgen rays. The fragments of the scaphoid were in good position, and the arm was put in a cockup splint for ten days.

Massage and electrical treatments were instituted five days after the injury, with the result that at the end of twelve weeks the man returned to work with a fairly useful hand.

A REVIEW OF UROLOGIC SURGERY

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KIDNEY

Ligation of the Renal Pedicle.—Uteau [1] discusses several methods of ligation of the renal pedicle. A ligation en masse, including the ureter, is occasionally practiced, but is not advisable in all cases, as the efficiency of the ligation tends to be decreased if the ureter is thickened, infected and dilated. A ligation en masse, after separation of the ureter, is used by many operators. Albarran advised ligation by fixation. Clamps are not used in this method, and the pedicle is ligated in sections by means of a blunt needle and ligature. Cathelin separates the various portions of the pedicle and ligates them separately. Uteau separates the ureter from the pedicle and places a ligature around the vessels. He clamps a section of the pedicle and cuts on the renal side, places a second clamp in a slightly different plane, and cuts through the pedicle. After placing a separate ligature on the clamped segments, he removes the forceps.

[ED. NOTE.—We have used these methods described for ligating the renal pedicle, but lately have come to use the technic described some years ago. This is very similar to the plan described by Uteau. As we employ it, the two clamps are placed on the pedicle before it is cut into at all. The pedicle is cut off on the renal side of the second clamp. A ligature is placed on the pedicle just as the deepest clamp is released, so that this ligature closes down on the tissue of the pedicle that has been crushed by the clamp. During the tying, the pedicle is controlled by the second clamp. A second ligature is then placed before the outer clamp is removed. The difference between the method described by

1. Uteau: De la ligature du pédicule rénal dans la néphrectomie, Paris méd. **53**:212-215, 1924.

Uteau and that employed by us seems to be in the placing of the clamps. In either scheme, the use of the two clamps gives excellent control of the pedicle.]

Complications, Following Nephrectomy.—Fronstein [2] says that injury to the peritoneum is the most common complication following nephrectomy; if this is unrecognized, or if there is suppuration, peritonitis may result. The peritoneum is most likely to be injured in cases of fistula, or when there is a tumor adherent to the peritoneum, so that in the dissection the parietal peritoneum is removed. If the peritoneum is quickly closed, even in the infected cases, peritonitis rarely occurs. Intestinal injury is not uncommon and may lead to fecal fistulas which require secondary operations for closure. Wounds of the ascending and descending colon, even if recognized at the time of operation and sutured, will probably break down and become fistulous. Secondary closure and even resection are sometimes necessary. The right renal pedicle lies close to the vertical portion of the duodenum, and this may easily be injured by clamps, with resultant duodenal fistula. Such fistulas, if persistent, invariably lead to death. Closure is difficult but must be attempted at once. Intestinal hemorrhage following nephrectomy sometimes occurs; Federoff noted it five times in 206 cases. It is explained as due to thrombosis of the veins of the intestinal walls with subsequent necrosis. It is seldom of consequence. Injuries of the diaphragm occur rarely without injury to the pleura. If these are closed at once, usually no harm will result. The pleura is most often opened in the beginning of the operation, when the high lumbar incision, beginning over the twelfth rib, is used. If the twelfth rib is absent or incompletely developed, the accident is most likely to happen.

Albarran recommends starting the incision somewhat lower and dissecting the sinus pleuralis bluntly upward, rather than cutting into it. The mortality following injury of the pleura is disputed. Proskurin asserts that in three out of four cases the patient will succumb to pneumothorax or empyema. Fronstein believes that, if the opened pleura is sutured at once, usually nothing more will be heard of the accident and no intrapleural inflammation will occur. Hemorrhage from accessory vessels, from short renal pedicles, or sclerotic, friable vessels which are clamped with difficulty and break off easily so that ligation is difficult, and from an injured vena cava, is discussed. The use of clamps left on the pedicle for from seventy-two to ninety-six hours, Marion's method of seizing a pedicle (which has slipped away) between the fingers, compressing it and using a tampon until the individual vessel can be seen, and the avoidance of ligating the ureter and the vessels

2. Fronstein, R.: Ueber der Komplikationen bei der Nephrektomie, Ztschr. f. urol. Chir. **16**:51-69, 1924.

en masse are recommended in suitable cases. The renal pelvis and ureter should be separated definitely, the ureteral end isolated from the vessels and the latter ligated. Secondary infection or suppuration of the ureteral end may at times lead to late hemorrhage from necrosis of an intimately associated vessel. The renal vein and vena cava may be infiltrated in cases of tumor, and may be ruptured. These accidents are serious; in many cases, injury to the vena cava results in death. Closure with suture, clamp application for several days, and ligation of the vena cava above and below the site of rupture are procedures used. The latter method gives the best results. In seventy-five cases of injury to the vena cava, there were twenty-two deaths (29 per cent.).

The care of the end of the ureter after nephrectomy is considered. Silk should never be used as a ligature in cases of tuberculosis. Urinary reflex from the bladder occasionally occurs, especially in cases of tuberculosis and of pyonephrosis when the ureter is dilated. Boeckel asserts that in tuberculosis this backflow from the bladder occurs only if there is ulceration of the bladder and consequent spastic contraction. It usually occurs in infectious cases. The ureteral fistula may persist for months. This is one of the arguments for complete ureterectomy in cases of severe infection and tuberculosis. Giordano and Kelly even recommend resection of the ureterovesical portion of the bladder. Israel has shown that fistulas occur in 10 per cent. of such cases, whether or not there is so-called complete ureterectomy. Marion recommends non-resection of the ureter and instead uses the cautery or carbolizes the end of the ureter so as to destroy the mucosa and enhance quick healing.

The question of functional disturbance in the remaining kidney immediately after nephrectomy is considered. This depression of renal function may lead to anuria or oliguria with uremia which may be transient, or may lead to death. Barth, Albarran and others believe this to be a reflex anuria due to nerve trauma at the time of operation, while Israel believes it due to heart weakness with subsequent fall of the blood pressure in the renal arteries. Fronstein feels, however, in the light of the work of Enderlen on animals, of Kümmel on histologic specimens in such cases, and of Jenkel's clinical report, that the oliguria following one-sided nephrectomy is due to toxic inflammatory changes in the renal epithelium which result in a kind of toxic nephritis. The possibility of reflex anuria from nerve injury is not denied, however. Hematuria from one kidney following removal of the other occurs rarely, and is explained as being due to physiologic, not pathologic changes, such as compensatory hyperemia.

[ED. NOTE.—Injury to peritoneum, intestine, pleura or vessels, if recognized and repaired at once, seldom leads to trouble unless the injury to a vessel is extensive. Occasionally, if the pleura has been

opened, especially in removing pyonephrotic or tuberculous kidneys, empyema may result. In clean cases, no harm comes from opening the pleura or peritoneum. Cases have been noted of a rapidly disseminating tuberculous pneumonia following pleural injury in removing a tuberculous kidney. The peritoneum has a remarkable power of resistance and rarely becomes infected, even in the presence of extensive infection. Sloughing of the duodenum with fistula developing in about one week's time has occurred in a few cases in which the nephrectomy was technically very difficult. Immediate repair by abdominal operation has been the best plan in these desperate cases. Care of the ureter following nephrectomy has long been a problem. The use of permanent ligature has been discarded by most surgeons. Many use no ligature, but merely clamp the ureter and divide with cautery. Under such circumstances, fistulas develop much less frequently. Judd's method of cutting the ureter with the cautery, ligating with catgut and drawing the ureteral stump through a rubber tube, isolates the infection and gives a comparative protection to the rest of the wound; it has been employed satisfactorily in a large number of cases.]

Technic in Complications Following Nephrectomy.—Nicolich [3] comments on Fronstein's article with regard to complications following nephrectomy. Fronstein advises the removal of clamps from the renal pedicle from forty-eight to seventy-two hours after nephrectomy, in cases in which no ligature has been used. Forceps pressure should be used only in cases in which ligation would be difficult and insecure. In cases in which it is impossible completely to isolate the vascular pedicle, or in which there is a large amount of inflammatory thickening in the region of the renal vessels, clamps are much safer than ligation. Küster advised removal of these clamps from twenty-four to thirty-six hours after application. Nicolich cites a case in which the vessels were not obliterated three days after clamping; he leaves his clamps in place for from three to six days after operation. The duration of clamping makes no difference in the final closure of the wound or the appearance of the scar.

[Ed. Note.—In the average case, seventy-two hours is sufficient to obliterate the renal vessels. In cases in which the vessels are diseased, this may not completely control bleeding. In two cases from the Mayo Clinic, small plugs of carcinoma of the kidney had extended into the renal vein and prevented adhesions between the walls of the veins. Usually, the clamps should be loosened seventy-two hours after the operation, left in place for six hours, and then removed. Clamps should never be removed at the time that they are unlocked. Six hours later,

3. Nicolich, G.: Bermerkungen zur Arbeit Fronsteins, "Ueber der Komplikationen bei der Nephrektomie," Ztschr. f. urol. Chir. **16**:165-166, 1924.

the vessels will have separated themselves from the clamps, and drawing the clamps away cannot loosen a clot. If any bleeding occurs, the clamps may be tightened and left in place for from thirty-six to forty-eight hours longer. Whenever possible ligation is desirable, but, in some cases, particularly if a subcapsular nephrectomy has been performed, clamps are preferable.]

Innervation.—Ambard [4] discusses innervation of the kidneys. The nerve branches forming the renal plexuses arise principally from the inferior part of the solar plexus and from the adjacent aorticorenal ganglion. Nerve terminations are found even in the arteries of small caliber, and are located in the deep layers of the adventitia and the muscle. Small branches go to the afferent and efferent vessel of the glomeruli and also to the capsule of Bowman. Recent researches suggest small filaments which end between the epithelial cells of the canals. Sensory nerves have been demonstrated by Smirnow and Kolliker in the smooth muscle tissue of the renal pelvis. The capsule itself also receives a number of branches. Ambard gives the following conclusion with regard to the activity of the renal nerves: (1) Section of the nerves to the kidney at the level of the pedicle does not cause degeneration of the organs; from this it may be deduced that there is an autonomous center in the organ itself; (2) stimulation or section of the nerve does not produce constant modification of secretion; (3) stimulation of regional centers causes a lowering of the renal threshold, suggesting that the nervous system exerts an influence over the renal threshold under certain conditions, and (4) if the nerves to one kidney are cut and those to the other are not, the secretion in the two kidneys is identical in the absence of abnormal stimulation. Apparently, the extrarenal nervous system does not affect either the renal threshold or the action of the capillaries.

Tumors.—Steinthal [5] reports a case of benign papilloma of the renal pelvis. The patient died several months later after a period of severe headache and coma. It is difficult to decide in tumors of this type, at the time of the operation, what the outcome will be. In a number of cases reported as benign, malignant tumors have recurred. The secondary growth may be local or it may be in the ureter or bladder. Hryntschak reported sixty-eight cases, of which six were benign. Spiess found forty-five of a series of ninety-five to be benign.

[Ed. Note.—A considerable number of cases of benign tumors of the renal pelvis have been reported in the last few years. At first

4. Ambard, L.: De l'innervation rénale, J. d'urol. méd. et chir. **17**:501-508, 1924.

5. Steinthal: Zur Kenntnis der Zottengeschwülste, des Nierenbeckens, München. med. Wchnschr. **71**:1238-1239, 1924.

nephrectomy was performed, until it was found how often recurrence developed in the ureter and bladder. If the patients are operated on before the disease has advanced too far, and the kidney and ureter are removed down to the bladder, there is every prospect of a good result. The bladder should be examined from time to time after the nephrectomy to make sure of early treatment in cases of recurrence in the bladder. In diagnosing a papilloma of the bladder cystoscopically, it should be borne in mind that the papilloma may be an extension from the original papilloma in the renal pelvis. A most beautiful specimen of renal papilloma and its extensions to the ureter and bladder can be seen in the laboratories of the late Professor Zuckerkandl.]

Epithelioma.—Duroux and Phélip [6] report a case of epithelioma in a kidney in which a pyelonephritis had existed for a long time. The kidney was removed successfully and on histologic examination a carcinoma of the clear cell type was found. The interesting feature in this case is the long premalignant period, from twenty-five to thirty years. Marion reports a somewhat similar case.

[ED. NOTE.—It is quite unusual for cancer of the body of the kidney to develop after a long period of infection. Infection and sclerosis of the renal tissue are occasionally associated with small benign adenomas and fibromas. Tumors of the renal pelvis may have a long standing, possibly premalignant history of trauma and infection. Oraison reports the case of a woman, aged 50, whose symptoms of renal trouble started with trauma at 24. At operation a squamous cell tumor of the renal pelvis was found. In an occasional case of long standing, especially if stones are present, there is a definite increase in the severity of the symptoms, suggestive of the onset of malignancy. In 108 cases of associated renal calculi and malignancy, collected by Martin and Mertz, the symptoms of stone averaged nineteen years; the symptoms suggestive of malignancy averaged about five months.]

Leukoplakia.—Hinman [7] says that leukoplakia plays a definite part in the development of squamous cell carcinoma of the urinary tract. He reviews, with Kutzmann and Gibson, thirty-three cases of leukoplakia of the renal pelvis. Leukoplakia in the renal pelvis is usually associated with urinary infection; calculi and hydronephrosis also are often found. In seven cases, leukoplakia also was found elsewhere in the urinary tract. Corsdress found that eighteen of twenty-one cases were unilateral, which is important since it permits radical

6. Duroux and Phélip: Localisation d'un épithélioma sur un rein atteint de pyélonéphrite chronique avec symptomatologie intestinale sans hématurie, J. d'urol. méd. et chir. **18**:42-47, 1924.

7. Hinman, F.; Kutzmann, A. A., and Gibson, T. E.: Leukoplakia of the Kidney Pelvis, Surg., Gynec. & Obst. **39**:472-489, 1924.

surgical procedures. Early diagnosis and immediate nephrectomy will save the patient much suffering. If nephrectomy is contraindicated, palliative measures, such as lavage with silver nitrate solution, may be tried.

[ED. NOTE.—Leukoplakia is usually considered as a lesion of the mucous membrane of some part of the buccal cavity, as it is very common there. Leukoplakia, in itself, is not malignant; in the mouth, it is a syphilitic infection or the result of local irritation. If it persists long enough, it is almost certain to become malignant, and it may become virulent and rapidly fatal. I do not know whether any of the leukoplakias of the renal pelvis have been associated with syphilis. Most of our cases have occurred in infected kidneys, usually with stones and clear evidence of irritation. Usually, the condition was not recognized until the kidney had been studied in the laboratory. Undoubtedly, leukoplakia plays a definite part in the development of squamous cell carcinoma of the urinary tract, just as it does in such development in the mouth.]

Calculi.—In a series of forty-six cases of renal stone, Lanzillotta [8] found nine in which there was no pain. Hematuria was the only symptom in five, pyuria in three, and pregnancy in one. Marion asserts that all cases in which there is a persistent total pyuria should be examined by the roentgen ray. Cases of stones in the kidney in which symptoms are few or latent are not unusual. In some cases, a few premonitory symptoms may be almost completely quiescent for many years; in the meantime, the stones are causing partial or complete destruction of the renal substance.

Chute [9] believes that renal calculi lead to greater destruction of renal tissues than any other surgical lesion. In six of the fifty cases reviewed, nephrectomy was necessary. There was also a seventh case in which nephrectomy was not done because of the patient's condition, and twelve cases in which there was extensive renal damage. Thus there was serious renal damage in approximately 40 per cent. of Chute's series. In many cases, the serious damage could have been prevented by removal while the stones were still small and the kidney uninfected. Chute calls attention to the fact that, although all of his fifty patients had complained of pain in the loin at some time or other, it was not usually of the typical, excruciating type. The nonobstructing stone without infection causes much less pain, often only an uneasiness, or at most, a dull ache. Frank hematuria was found in

8. Lanzillotta, R.: Des calculs latents du rein, J. d'urol. méd. et chir. **17**:466-471, 1924.

9. Chute, A. L.: An Analysis of Fifty Cases of Renal Calculi, J. Urology **12**:417-424, 1924.

only six of his cases, and, in a few, there was no microscopic blood. In many cases, there was prolonged delay in removing the stone after diagnosis had been made. Although the importance of the progressive destruction is emphasized, Chute does not advise immediate removal of all stones from the kidney; if there is no infection or obstruction, the stone may be watched for a considerable period.

Lévy [10] reports 378 cases of urinary calculi in which operation was performed in the Service Civiale at the hospital Lariboisière. One hundred sixty-seven patients had stones in the bladder; fifteen (8.9 per cent.) died following operation. The stone was removed by lithotrity from fifty-nine; three died; it was removed suprapubically from 106 patients; twelve (11.3 per cent.) died following operation. Five died from urinary infection. The prostate was removed at the time of lithotomy from four patients; two died. The eighth patient died from spinal anesthesia. One patient's bladder was ruptured by the fluid used to distend the bladder before cystostomy; death occurred from peritonitis. One patient died from air embolism; the bladder had been distended with air before making the incision. One hundred sixty-six operations were performed for renal stones; twelve (7.2 per cent.) patients died. Sixty nephrotomies were performed; five (8.3 per cent.) patients died. Two patients died following emergency operations, a third died after nephrolithotomy on a single kidney. Two patients had hemorrhage following operation; secondary nephrectomy was performed on one; the kidney of the other was packed. Pelviolithotomy was performed on forty-nine patients; two (4 per cent.) died. Lévy favors a posterior incision in the renal pelvis, primarily because it permits of enlargement into the renal parenchyma. Posterior pyelotomy may be visualized; a large stone may be removed with a minimum of destruction of the renal tissue; bleeding is slight; the area of septic absorption is small, and there is very little drainage after operation. In one case in which the incision extended into the parenchyma, secondary nephrectomy was performed for hemorrhage. Thirty-eight primary nephrectomies were performed; two patients died. In twenty-seven cases, the kidney was functionless. In one case, an atrophied supernumerary kidney containing a cystin stone was removed. Nephrotomy was performed in nine cases; three patients died. This operation is usually performed only as an emergency. Two of the patients who died were anuric; the third died following an intervention on a single kidney. In eleven (5.5 per cent.) cases, bilateral stones were removed, and, in twenty (10 per cent.), secondary operations for stones were performed. Three patients

10. Lévy, Robert: Notes sur 378 interventions pour calculs urinaires. I. d'urol. méd. et chir. **18**:1-32, 1924.

in the latter group died following operation. In seven of the twenty cases, the stones were on the opposite side, either in the kidney or ureter. Thirteen stones that were probably true recurrences were on the side originally operated on. Three of the eleven patients on whom a bilateral operation was performed died. Stones were removed from the ureter in forty-five cases; five patients (11 per cent.) died.

[Ed. Note.—This unusual series of cases is interesting because it represents the work done during the last decade in one of the leading continental urologic centers. A number of the reviews of large series recently reported (Rovsing, Federoff) are of cases in which operation had been performed for a longer time. The mortality rates in these more extensive series include the cases in which operation was performed during the formative period of urologic surgery, and are not entirely comparable to more recent statistics. The percentage and types of different operations in Lévy's cases are similar to those mentioned in a recent report by Braasch and Foulds from the Mayo Clinic. Of 850 operations, 371 (43 per cent.) were pelviolithotomies. Nephrectomy was performed in 327 (38 per cent.) of the cases and a nephrolithotomy in 12 per cent. In Lévy's cases, nephrolithotomies were performed in 30 per cent. of the cases. Usually, removal of the stone through the renal parenchyma is considered a more hazardous procedure than pelviolithotomy, and is not practiced as frequently now as it was a decade ago. In only one of sixty nephrolithotomies was a secondary nephrectomy for hemorrhage necessary. In four of 104 of Braasch's cases, a secondary nephrectomy for bleeding was performed. In spite of postoperative bleeding in cases in which the parenchyma is incised, the series of nephrolithotomies in Braasch's cases were followed by the lowest mortality of any type of operation; there was only one death in 150 cases. Death occurred in three of eleven of Lévy's cases in which a bilateral operation was performed. The usual procedure was to operate on the more severely diseased kidney first. At present, we usually operate on the better kidney first; if obstruction or other trouble develops in the opposite kidney, the better kidney is able to function and sustain life until the opposite side is relieved. Five (11 per cent.) of the patients with ureteral stone died. Many of these operations were complicated. The present day mortality for uncomplicated removal of ureteral stones should not exceed 1 or 2 per cent.]

Hemorrhage Associated with Stones.—Cifuentes[11] asserts that infarcts and secondary hemorrhage are most common after nephrotomy, the result of cutting branches of the renal artery. When the infarct

11. Cifuentes: Fernresultate der Operationen wegen Nephrolithiasis, Ztschr. f. urol. Chir. **16**:169-170, 1924.

is aseptic, the bleeding is not extensive and results only in a partial sclerosis of the renal parenchyma. The renal function may improve after the operation. This may be marked in aseptic or slightly infected cases. With extensive infection, the function is usually diminished as a result of late fibrosis of the parenchyma. Recurrence of stone was found in seven (2 per cent. of aseptic cases). Calculi formed in the opposite kidney in from 3 to 4 per cent. after operation. The possibilities of a normal length of life are good after unilateral operations, but these are reduced 50 per cent. after bilateral operations.

Brongersma [12] reported 244 cases of renal stone. The average age of patients was between 30 and 50. The average mortality rate was 10.6 per cent. In patients over 60 it was 47.8 per cent., and under 60 it was 8.6 per cent. Thirty-six patients had bilateral involvement. Most of the stones contained oxalates and phosphates. In only one case was the stone composed entirely of urates. The late results varied according to whether a pyelotomy or nephrotomy was performed; they were decidedly better following removal of the stone through the renal pelvis. In a number of infected cases, the results were better following nephrectomy than after conservative operations. Pelviolithotomy is the operation of choice in aseptic or slightly infected cases. In bilateral infected cases, a bilateral nephrostomy with removal of the stone is advised.

Tardo [13] believes that, in cases of renal stone, pelviolithotomy should be the operation of choice and nephrectomy used only as a last resort. Nephrotomy should be performed when pyelotomy is contraindicated. In cases of unilateral infected nephrolithiasis, nephrotomy is a serious procedure, and the mortality is high. The operation is frequently followed by hemorrhage, generalized infection, formation of fistulas, and the recurrence of stone. Tardo advocates permanent nephrostomy in cases of bilateral recurrent stones.

[Ed. Note.—The views of continental urologists are largely in accord with those of American urologists. Incisions into the renal parenchyma are often followed by infection, necrosis and late bleeding with partial destruction of the function of the kidney. It is only in recent years that continental urologists have abandoned the practice of removing stones through the renal cortex and advised pelviolithotomy. On the other hand, there are unquestionably many cases in which nephrolithotomy is indicated, such as of small cortical stones, stones that are firmly fixed in one of the minor calices, or stones so large or so shaped that it is impossible to remove them through an incision in the pelvis. In a large series of cases reported by Braasch,

12. Brongersma: Ztschr. f. urol. Chir. **16**:170, 1924.
13. Tardo: Ztschr. f. urol. Chir. **16**:170-171, 1924.

nephrolithotomy was followed by very low mortality, only one death occurring in 150 cases. Nephrolithotomy, when indicated, should be made as conservatively as possible; extensive incisions into the cortex are rarely necessary. Braasch and Judd advise the combined nephropelviolithotomy in cases in which the stone is not readily accessible through the pelvis. Braasch and Foulds assert that the efficiency and safety of the combined operation is shown by the fact that there was only one death in fifty-eight cases, and that there was a recurrence of stone in only three of these, a little more than 5 per cent.

Regarding the question of when nephrectomy should be done on one side in cases of bilateral infection and calculi, it seems that, since the rather recent experiments of Hinman, our ideas will have to be revised. According to Hinman, when compensatory hypertrophy reaches a certain point as a result of interferences with function of the opposite kidney, it will probably continue until the enlarged kidney is carrying on all the function, and the badly damaged kidney will atrophy and cease to be of any value functionally. If this suggestion is proved by clinical experience, and I am sure it will be, then it would appear that the better of the two kidneys should be cleaned up in some of these bilateral cases, and the one most extensively infected removed. Preserving these old shells because they had some renal parenchyma in them has probably been the means of maintaining the renal infection and possibly one of the causes of the frequent recurrence of stones.]

Studies were made by White[14] of the density of calculi by comparison of shadows of stones exposed together on the same plate. Benoist says that the specific opacity of a simple substance depends on its atomic weight. Arcelin, following this principle, arranged a number of urinary salts in order of increasing density according to their atomic weights as follows: ammonium urate; uric acid; sodium urate; oxalate; calcium carbonate, and calcium phosphate. He says that the opacity of a calculus is determined by: (1) the nature of its constituents, (2) its structure, and (3) its thickness. By using sections of equal thickness of stones, their relative opacity may be arranged in the following order: uric acid; urate of calcium and of magnesium; ammoniomagnesium phosphate, and phosphate of calcium. This order satisfies the laws of Benoist. In reviewing the reports of various authors on the chemical analysis of stones, marked variations are noted. White, in a study of twenty-four stones, found that 75 per cent. contained calcium oxalate and 58 per cent. calcium phosphate in considerable amounts. For diagnostic purposes it is worthy of note

14. White, H. P. W.: The Radiographic Features of Urinary Calculi in Relation to Their Chemical Composition and Structure, with Special Reference to Renal Calculi, Brit. J. Surg. **12**:5-27 (July) 1924.

that one or the other of these salts was present in 91 per cent. of his series. In 66 per cent., one or the other of the salts was present in the central portion of stones. This is of importance when it is recalled that many stones give rise to severe colics when relatively in the nucleus stage, and detection by roentgen ray, while so small, will depend to a great extent on their chemical composition. In reviewing ureteral stones, White finds that more stones composed of uric acid reach the bladder than do those composed of oxalates. A smaller percentage of vesical stones are shown by the roentgen ray than of renal stones. Uric acid and urates form a much larger bulk of the individual vesical stones than they do of renal stones. The identification by roentgenogram of many stones in the bladder, whose composition is largely uric acid and urate, is often due to the presence of calcium in the form of earthy phosphate or oxalate. Phosphate is found in larger proportions as a constituent of vesical stone than of renal stone. It frequently surrounds a nucleus of oxalate, or uric acid or urate.

[ED. NOTE.—With refinement of roentgen-ray technic, many of the so-called shadowless stones are now detected. In a large series of cases, it was found that about 95 per cent. of all renal and ureteral stones gave positive shadows in the roentgenogram. The most common shadowless renal stones, as determined in a recent study by Culligan, are usually composed of pure cystin, xanthin or uric acid. These stones may only be diagnosed by areas of greater translucency in the ureteropyelogram.]

Culligan says that it has been noted by various observers that renal stones composed of cystin, xanthin or uric acid give less dense shadows when exposed to the roentgen ray than stones of other composition. Stones composed purely of the foregoing substances cause no shadows when exposed to the roentgen ray. The diagnosis of shadowless renal calculi is difficult, although not impossible, if one keeps in mind the fact that they do occur. The diagnosis is made by finding an area of greater translucency in the pyelogram of the renal pelvis than is cast by the pyelographic medium. A positive history of renal stones with a negative roentgenogram should lead one to search carefully for the area of greater tranlucency in the pyelogram or ureterogram. Stones of this kind do not cast shadows when fluoroscopy was done at the operating table, and for this reason it is difficult to know whether or not fragments are left. If there is doubt, it may be advisable to perform a nephrectomy.

Double Kidney.—Bennemann [15] reports a case of complete absence of the right kidney, and a left kidney with a cystic lower segment.

15. Bennemann: Ueber rechtsseitigen Nierenmangel mit gleichzeitig linksseitiger Doppelniere in einem Falle, der wegen Hämaturie in Behandlung kam, Ztschr. f. Urol. **18**:335-339, 1924.

The lower kidney, which was much smaller than a normal kidney, and the pelvis were cystic and filled with blood. This rudiamentary kidney was connected to the upper kidney partly by parenchymatous and partly by connective tissue, and it had a separate blood supply. The lower segment was removed.

[ED. NOTE.—The removal of a segment of a kidney or even a resection removing half of a diseased kidney is being recognized as a practical procedure in certain cases. It will probably never be applicable for malignant conditions or tuberculosis. If there is a normally functioning kidney on the opposite side, there is always the possibility of the sound kidney taking over all the work through a compensatory hypertrophy. The whole problem of compensatory function should be kept in mind when the advisability of renal resection is being considered. Hinman's experiments would seem to indicate that when a compensatory hypertrophy has reached a certain point it will continue in spite of a complete restoration of the damaged kidney, so that eventually the damaged kidney will atrophy completely and cease to function. If it can be demonstrated before operation that the healthy kidney has reached the stage at which it is carrying out most of the renal function, then the only reason for preserving any renal tissue on the diseased side is destruction of the sound kidney.]

Ectopic Kidney.—Darner [16] described two cases of bilateral ectopic kidneys and reported cases from the literature. One patient, a girl, aged 19, had symptoms and physical findings of salpingitis. At operation both tubes and ovaries were found to be quite normal but displaced anteriorly by bilateral retroperitoneal masses. In the left pelvis, there was a large oval mass extending about 8 cm. both above and below the iliopectineal line. The mass was retroperitoneal and had penetrated under the posterior leaf of the left broad ligament. This was the left kidney and the ureter passed directly to the bladder. On the right side, the lower pole of the right kidney was at the level of the iliopectineal line. Its pelvis pointed anteriorly. The patient was sterilized, as it would be impossible for pregnancy to terminate successfully. Bilateral ectopic kidneys are usually smaller than normal. Fetal lobulation is usually retained, and the shape of the kidney is markedly distorted from the pressure of neighboring structures. These kidneys usually receive their vascular supply at a much lower level than normally. The vessels are usually smaller than normal and multiple. Most bilateral ectopic kidneys are in young persons. The mortality and morbidity is high, but the condition is not incompatible with a normal life. Several persons died late in life from other causes, and the condition was discovered at necropsy.

16. Darner, H. B.: Bilateral Ectopic Kidneys, J. Urology **12**:193-214, 1924.

Miscellaneous Anomalies.[17]—In 560 renal operations in Federoff's clinic during the last twenty years, three cases of aplasia, one of hypoplasia, five of horseshoe kidneys, four of double kidneys, and five of dystopic kidneys were observed, 3.2 per cent. of the 560 cases. Naumann's statistics show a 1 per cent. occurrence, and those of Guizetti only 0.4 per cent. It is estimated that one-third of all persons suffering from such renal anomalies receive hospital attention. Aside from the complaint of tumor or subjective sensations from pressure on other organs, the morbidity of such abnormal organs is high, due probably to the anomalous position of the renal pelvis and to the abnormal course of the ureter. Hydropyonephrosis and stone occur most frequently. Owing to interference with proper functional elimination of the nitrogenous bodies, of bacteria and toxins, anomalous kidneys are predisposed to nephritic, tuberculous and pyogenic disease. Double kidney is of interest because of the many forms it can assume. In one of the cases, the division line between the double kidney could scarcely be determined, while, in another case, the division was very definite and widespread. The double kidney has two pelves, as a rule, not communicating. The double ureters may unite in some part of their downward course or may open into the bladder by two separate ostia. Frequently, the ureter of the lower half of a double kidney may open into the bladder on the opposite side, as in crossed dystopia. The possibility of disease in one part of a double kidney with the remaining part functionally intact calls for accurate investigation; all the methods of roentgenology, pneumoperitoneum, pyelography and cystoscopy may at times be used. The discovery of a double kidney at operation, with previous report of normal ureteral openings, places the surgeon at a disadvantage. He does not know whether the opposite kidney is normal and which part of the kidney being operated on is diseased. Two empirically known laws may help. The ureter from the lower half of a double kidney goes over to the opposite side if the kidney on that side is missing, and again with bilateral opening of the two ureters of a double kidney the medial or medial-caudal opening belongs to the ureter of the upper part (Meyer-Weigert).

[Ed. Note.—During the last ten years, particularly the last five years, with the universal application of cystoscopy and roentgenography, renal and ureteral anomalies have been found with greater frequency. The work of Eisendrath and of Braasch, Judd and Scholl, from the anatomic, pathologic, diagnostic and surgical aspects, has been quite comprehensive. The cystoscopic examination can hardly be complete

17. Dobrotworski, W. M.: Ueber einige Formen der Nierenmissbildungen, Verhandl. d. XV Russ. Chir. Kong., St. Petersburg, 1922-1923, pp. 327-329; abstr. Ztschr. f. urol. Chir. **15**:70-71, 1924.

without a careful search for a second ureteral opening on the same side. If there is any suspicion of an anomaly, and double openings are not found, a ureterogram taken with the catheter drawn low in the ureteral course will not infrequently reveal a second ureteral branch, leading to a second pelvis. If in primary pyelography the pelvis lies low or high or a lower or upper major calix is absent, the possibility of duplication of the pelvis or ureter should be considered.]

Cysts.—Soupault [18] reports a case of hydatid cyst of the kidney which was removed at operation. The patient, a woman, aged 53, had had attacks of renal colic for sixteen years, which had probably been caused by the passage of daughter cysts. Soupault divides the clinical course of the disease into three periods. In the first period, the cysts are latent and give no clue to their identity. In the second period, in which the cysts have broken into the renal pelvis, attacks of renal colic, which occasionally occurred during the first period, are now more frequent and are terminated by the expulsion of the small vesicles. In the third period, the kidney becomes infected and pyonephrotic.

Pousson [19] differentiates true polycystic kidneys, small cysts with nephritis, and large serous or hemorrhagic cysts. The small cysts with nephritis are usually found at necropsy. Their walls consist of thick fibrous tissue and are covered with cuboid epithelium. These cysts contain clear, exceptionally bloody urine-like contents. Anatomically, they are considered retention cysts, and the disease presents the syndrome of chronic nephritis. Therapeutically, decapsulation or nephrectomy may be considered when there are a great many cysts (approaching the condition of true polycystic kidney). The large serous cysts are not common; they may reach the size of ovarian cysts and are chiefly in the lower pole of the kidney, and do not connect with either the renal pelvis or ureter. These cysts may arise from mechanical cause, may be neoplastic or "dysembryoplastic" in origin, according to the various theories advanced. As long as they are small, they remain clinically latent but, with increasing size, they produce functional and physical changes, such as renal colic, dyspepsia, constipation, meteorism, dyspnea, edema and disturbances of the heart. The renal function and urine tend to remain almost normal. The physical symptoms are those of renal tumor. The course of the disease is prolonged. Suppuration and rupture seldom occur. To be differentiated are nephroptosis and hydronephrosis. Puncture, incision and

18. Soupault, R.: Kyste hydatique suppuré du rein gauche, J. d'urol. méd. et chir. **17**:484-489, 1924.

19. Pousson, Alfred: Les kystes du rein (Nierencystein), J. de méd. de Paris, 1923, pp. 315-320; 337-340; abstr., Ztschr. f. urol. Chir. **15**:95-96, 1924.

drainage are unsatisfactory operative procedures. The method of choice is nephrectomy, as partial resection leads to bleeding, fistula and other sequelae. Large hemorrhagic cysts present much the same features as large serous cysts, so far as symptoms, diagnosis and treatment are concerned. Polycystic disease is nearly always bilateral. Often there is cystic affection of other organs, especially the ureters and bladder. Theories such as pathogenetically congenital, neoplastic and inflammatory, are advanced. Pousson is inclined to believe that all three factors may play a part. The symptoms of chronic nephritis, hematuria (early), pain in the lumbar region, at times true renal colic, and palpable tumor are diagnostic features. The tumor may be felt in two-thirds of the cases. The disease runs a long course. Most urologists desist from operative procedures if the patient is under 20. Nephropexy, puncture, decapsulation and nephrotomy, with or without renal pelvic drainage, are considered, but in early cases not indicated. Nephrectomy in unilateral disease is ideal. However, the author believes that surgical treatment cannot influence the course of the disease permanently. In certain cases, nephrectomy, as a palliation, may be done.

[ED. NOTE.—The treatment of polycystic disease of the kidney remains an enigma. In this country, the results of the multiple puncture operation and other surgical measures have led urologists, as a whole, to the conclusions mentioned. Unless the disease is unilateral and nephrectomy can be performed, our only choice seems to be to treat the patient along the lines laid down for chronic nephritis. At best the outlook is discouraging. Rovsing meticulously punctures all cysts, great and small. He is extremely careful not to traumatize the remaining substance of the kidney. After conservative operations of the type advised by Rovsing, it is possible for the patient to bleed to death through the area occupied by the previously distended kidney. Gentle manipulation is very essential in carrying out any conservative operation in such cases.]

Infections.—Dyke and Maybury [20] define "ascending" renal infection as passing into the kidney by way of the lumina of the urinary passages. In the experiments designed to bring about infection of the ureter from the bladder, they found that, under certain conditions, the ureterovesical valve was an impassable barrier to the passage of infection from the bladder upward. By direct infection of the lumen of the ureter, it was possible to bring about infection of the kidney; but this infection was due, not to regurgitation of the infected pelvic

20. Dyke, C. S., and Maybury, B. C.: On the Attempted Production of an "Ascending" Renal Infection, Brit. J. Surg. **12**:106-118, 1924.

contents into the renal tubules, but to direct spread through the epithelium of the renal sinus into the interstitial substance of the kidney. Carmin injected into the pelvis did not pass through its renal papilla, which appeared as an insuperable bar to a reversal of the urinary flow. No evidence was produced of the possibility of an ascending renal infection.

[Ed. Note.—The experiments of Dyke and Maybury are fairly conclusive, but one is impressed by the fact that in each of their experiments, of which there were several, only one or two animals were used. In recent experiments by Cunningham and Graves, which were carried out on a large series of animals, they found a regurgitation of vesical contents into the ureter in 73 per cent. of seventy-five rabbits with normal bladders. In rabbits in which the ureters had been disturbed by previous surgical procedures, reflux was produced in thirty-three of forty-two attempts. Reflux and renal infection are not infrequently associated.]

Pyelitis.—Lepper and Martland,[21] noting the marked general improvement without corresponding improvement in the amount of pus and bacilli in the urine in cases of pyelitis, investigated the possibility of the symptoms being due to acidosis. A series of six patients with pyelitis due to colon bacillus was observed, and in none was there any noticeable diminution in the alkali reserve in the blood. Two patients were also observed under treatment, and in neither did the administration of alkalis greatly change the alkali reserve. The hydrogen ion concentration of the urine of three treated patients showed a definite increased alkalinity that corresponded closely to the improvement of the patients. The authors conclude that: (1) No evidence has been found experimentally or clinically of acidosis in cases of acute coliform infections of the urinary tract; (2) the alteration in the amount of pus and bacilli in the urine following alkaline treatment is not sufficient to account for the improvement which takes place in the patient's symptoms, and (3) this improvement appears to be definitely associated with a decrease in the hydrogen ion concentration of the urine, and it is reasonable to assume that urine of a high hydrogen ion concentration irritates the inflamed mucous membrane of the urinary tract.

Matusovsky[22] treated seventeen women with pyelitis with neoarsphenamin. In most instances, a bacteriologic examination had been made, and apparently no discrimination used in the treatment either

21. Lepper, E. H., and Martland, M.: The Alkali Reserve of the Blood in Coliform Infections of the Kidney, Lancet **2**:485-487, 1924.

22. Matusovszky, Andreas: Ueber Behandlung der weiblichen Pyelitiden durch Neosalvarsan, Ztschr. f. Urol. **18**:445-451, 1924.

of coccal or bacillary types of infection. Eight of the seventeen patients were definitely cured after several injections. A number of these apparently had had pyelonephritis for a long time.

Tuberculosis.—Bandel [23] reports conclusions from a detailed study of cases of renal tuberculosis (from 1907 to 1923). Sixty-four per cent. of women were affected and 36 per cent. of men. The second to fourth decades in women and the fourth to sixth decades in men were the periods of greatest frequency. The incidence of renal tuberculosis in men with high grade urethral strictures (57 per cent.) is striking. In only a few cases was the condition primary. The initial diagnosis of renal tuberculosis was seldom made, intestinal inflammation, cholecystitis, gonorrheal or nonspecific infection being confused with the disease. Only fourteen of twenty-five cases were immediately recognized as renal tuberculosis. With bladder inflammation and undetermined symptoms of pain in the lower part of the body, renal tuberculosis should be considered. Before cystitis appeared, there were symptoms of pain in the region of the kidney, in the lumbar region, and in the lower part of the body, in all cases. There was blood in the urine in 25 per cent. of the cases, and cloudy urine with pain in the bladder in 5 per cent. No absolute method of diagnosis is known except by ureteral catheterization and animal inoculation with the urine thus obtained, or the demonstration of the bacilli of tuberculosis therein. Pathologically, we deal with a tuberculous pyelonephritis. The blood stream is first invaded. Breaking down of caseous nodes or extension of the bacilli through the natural urinary passages, or through the lymph passages to the renal pelvis, forms the mode of infection. Extension through the kidney is through the lymphatics to the cortex, to the ureters and bladder by means of bacilli or tuberculous detritus passed with the urine. Ascending infection from the bladder to a noninfected kidney is possible.

From the therapeutic standpoint three groups are differentiated. First, are cases of bilateral renal tuberculosis. Here conservative treatment is in order. With slight infection of one kidney, the removal of the more diseased opposite kidney seldom leads to improvement. At best the patient's life is somewhat lengthened, and he is slightly more comfortable. Second, are cases of unilateral tuberculosis in which the function of the opposite kidney is greatly impaired by previous disease. Care must be taken not to extirpate the tuberculous kidney under such circumstances. Slight albuminuria in the nontuberculous kidney is not a contraindication to operation. Third, are cases of unilateral tuberculosis in which the opposite kidney is functioning

23. Bandel, R.: Ein Beitrag zur Klinik der Nierentuberkulose, Ztschr. f. urol. Chir. **15**:72-102 (Feb.) 1924.

well. Here, immediate nephrectomy is indicated. The earlier the renal tuberculosis is diagnosed the less the bladder involvement; the more localized the disease and the less tuberculosis there is in the entire body, the more favorable is the prognosis for quick and permanent cure. Surgical treatment yielded 72 per cent. cures in the series, and is recommended. Heliotherapy and similar methods of conservative treatment were on the whole unsuccessful. With surgery the danger of ascending infection to the opposite kidney is lessened, and the persistence of bladder symptoms is to a great extent overcome. The immediate mortality from surgical treatment was 4 per cent., the late mortality, estimated from follow-up records, was 8 per cent., a total of 12 per cent. Permanent cure was obtained in 72 per cent. of the cases. Intensive study from the physical diagnostic, cystoscopic and laboratory standpoints is emphasized. Bandel believes that ureterectomy should be done in most cases, and that care should be taken to remove as much tuberculous tissue as possible.

[ED. NOTE.—The foregoing views are parallel to those in this country at the present time. The fact that renal tuberculosis is seldom primary but is part of a general disease is emphasized, and it is from this point of view that therapeutic advances are to be sought. Bandel's study directs attention to the frequency with which renal tuberculosis is not diagnosed at a time when the outlook for surgical cure is best; that is, when the bladder symptoms are not marked. The failure of many practitioners to keep up the search for the bacilli of tuberculosis in the face of persistent pyuria, either by miscroscopic or inoculation methods, cannot be too strongly condemned.]

Cholecystnephrotomy.—Kapsinow [24] has advised a method of anastomosing the gallbladder to the pelvis of the right kidney which, with ligation and division of the common duct, excludes the bile from the intestinal tract. The kidney is split in its convex surface, into which the dependent portion of the gallbladder, in which the opening has been made, is sutured to the pelvis of the kidney by a series of mattress sutures. The operation is usually done in two stages, the second stage consisting of isolating and ligating the common duct. This procedure is offered merely as a means of directing the bile stream away from the intestine, and is of interest to the urologist on account of the action on the kidney. The kidney atrophies and appears diminutive and hydronephrotic, with only a shell of renal tissue remaining. Periodic catheterizations revealed clear and uninfected urine and histologic studies of the urinary bladder; the anastomosed kidney and the liver showed no evidence of infection.

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24. Kapsinow, R.; Engle, L. P., and Harvey, S. C.: Intra-Abdominal Biliary Exclusion from the Intestine; Cholecystnephrostomy, a New Method, Surg., Gynec. & Obst. **39**:62-65 (July) 1924.

[ED. NOTE.—It is unusual that such large amounts of bile caused no irritation or infection in the urinary tract. With fistulas between the upper ureter or renal pelvis and the intestinal tract, even when infection is slight or absent in the duodenum, marked irritation and infection are usually present. On the other hand, it must be mentioned that, when such cases occur clinically, they are usually preceded by infection or other sources of irritation. Kaufman reports a case in which there was a fistula between the duodenum and the pelvis of the right kidney. Duodenal contents were passed in the urine for years. On examination of the pelvis and ureter, it was found to be completely covered with papillomatous masses.]

URETER

Stricture.—Hunner [25] reports the results of his work on ureteral stricture. He sent out questionnaires to 300 patients with ureteral stricture who had been treated between 1910 and 1918, and bases his report on the first 100 replies received. Most of the patients were seen in early or middle life; many date their symptoms from childhood or early adolescence. Half of the patients had borne children. Fifty of the patients had bilateral stricture, and of the remainder thirty-one had strictures on the right side, and nineteen on the left. The majority of these strictures were located within 6 cm. of the ureteral orifice. Seventy-one patients had had a total of 109 operations. Hunner feels that ureteral stricture has an important etiologic bearing in cases of hydronephrosis and renal infections, particularly in pyelitis of pregnancy. He reports twenty-nine patients cured, fifty much improved, fifteen improved, and five not improved. Ninety-seven patients complained of pain in the back; it was completely or partly relieved in sixty-nine (71 per cent.) of the cases. Pain in the lower ureteral region was recorded in ninety-three cases, and was relieved wholly or in part in seventy (75 per cent.) of the cases. Bladder symptoms were recorded in seventy-nine cases, with complete or partial relief in sixty-three (80 per cent.). Fifty-four patients complained of headaches; complete or partial relief was obtained in 70 per cent. Sixty-seven patients reported a gain in weight.

[ED. NOTE.—Hunner's first papers on ureteral stricture were received with little enthusiasm and much doubt. His persistence in bringing this condition before the urologists together with a large array of cases has gradually convinced many of the importance of this condition. Aschner says, "Even if Dr. Hunner was 75 per cent. wrong,

25. Hunner, G. L.: End-Results in One Hundred Cases of Ureteral Stricture, J. Urology **12**:295-324, 1924.

I feel we would still be greatly indebted to him for drawing to our attention an explanation of some of the cases that we encountered and could not explain." Livermore says, "I have seen thirty-eight cases of stricture of the ureter during the last six months." Rathbun asserts that the most convincing point is that these patients are definitely and permanently relieved of these symptoms by dilatation when they have not been relieved by other procedures. McCarthy describes a new cysto-endoscope with which he is able to perform practically all the intra-ureteral operative manipulations in the male that Hunner does in the female. Lowsley diagnoses strictures on the basis of pyelograms and ureterograms. He also uses the wax bulb and McCarthy's new foroblique cysto-endoscope. Hunner says that a plain catheter is insufficient; it passes through two thirds of the stricture patients without the slightest difficulty. A bulb is necessary for the recognition of the stricture.]

Stone.—Hamer [26] reports ten cases of calculus in the lower ureter, and illustrates various methods of dealing with such cases and their complications. Unusually large calculi may require surgical procedures for their removal. If the stone is small, and good downward drainage is obtained, intra-ureteral manipulation will succeed in the majority of cases. If there are marked pathologic changes in the kidney above the stone, it should be removed surgically at once. In cases of impacted calculus, if intra-ureteral measures calculated to reestablish drainage fail, if there is infection above, or if the condition of the opposite kidney is such as to make delay dangerous, the calculus should be removed by operation. The conditions requiring surgical removal of a calculus are comparatively rare, when the large percentage of calculi passed spontaneously or after intra-ureteral manipulation is taken into account.

Pflaumer [27] recognizes the need for an instrument that can be introduced into the ureter and grasp the stone so that it can be drawn out. Such instruments have the disadvantage of causing an unknown, and at times dangerous, amount of trauma to the ureter. A ureteral sound is described, based on the principle of a snare for the bladder polyp. The snare is closed, the sound being passed up the ureter beyond the stone when the snare is opened. On withdrawal, the open snare at the end of the sound hangs on the stone and pulls it downward with a minimal amount of trauma to the ureter. Instances of removal of ureteral stone with this instrument are described.

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26. Hamer, H. G.: Some Problems of Calculus in the Lower Ureter, J. Urology **12**:325-334, 1924.

27. Pflaumer: Unblutige Behandlung der Uretersteine, Ztschr. f. urol. Chir. **15**:122-123 (Feb.) 1924.

BLADDER

Tumors.—Cancer of the bladder developing in anilin workers was first described by Rehn, in 1895. Posner [28] states that, up to 1920, 177 cases were reported. He also states that there are a great number of anilin workers in Germany, and consequently this does not necessarily indicate a high percentage of cancers of the bladder among them. It has been shown that the production of malignancy is associated with the amino-combining power of the benzenes. There is usually a long period between the first symptoms and the development and finding of a definite tumor; this varies between six and thirty years. There is also considerable variation in the type of tumor in different persons. In young persons, the cancer is likely to be a benign papilloma, while a more definite type is found in older persons.

Scholl [29] reports thirty-one cases of tumor of the dome of the bladder treated surgically at the Mayo Clinic. A transperitoneal resection was carried out in fourteen cases. Usually the bladder was opened first and then the peritoneal cavity. The general abdominal cavity was walled off with gauze, and unless there was marked contamination it was closed without drainage. None of the patients had peritonitis following operation. One patient died seven days, and five died from three to seven years after operation. Eight are still living; six have been well from one to eight years, and two have recurrences, three years after operation. In twelve cases, the bladder was resected, after the abdominal cavity was opened, and sutured to the anterior peritoneal fold of peritoneum to the bladder below the tumor. This maneuver permits an extraperitoneal resection of the growth. One patient died nine days after operation, and two during the next four years. Nine are still living. Seven are well from six months to seven years after operation, and two have had recurrences. In five cases, an extraperitoneal resection was carried out. There were no operative deaths, and two patients are known to be alive. In the entire group of cases, there were two operative deaths; of the remaining patients, nine subsequently died, and nineteen are known to be alive from one to six years after operation.

Radical extirpation of the bladder with implantation of the ureters into the bowel for cancer of the bladder has adherents and opponents, but the mortality remains colossal.[30] The operation of bilateral

28. Posner, C.: Zum Blasenkrebs der Anilinarbeiter, Ztschr. f. Urol. **18**:418-422, 1924.

29. Scholl, A. J.: Tumors Involving the Dome of the Bladder, J. A. M. A. **83**:1147-1152 (Oct. 11) 1924.

30. Damski, A.: Zur Frage der Harnableitung oberhalb der Blase bei inoperablem Blasencarcinom durch Nephro oder Ureterostomie, Urologia **1**, No. 3, 1924; abstr., Ztschr. f. urol. Chir. **15**:50-51, 1924.

nephrostomy or ureterostomy is occasionally employed in cases of extensive inoperable cancer. The object of the operation is to relieve the patient of the pain incident to the passage of urine into the bladder and the contraction of the bladder in voiding. It is also thought to lessen the amount of coincident infection. Six cases are reported in which this operation was done. Four patients were not relieved, and died soon. One was relieved definitely from tenesmus and pain, in spite of rapid growth of the cancer with pelvic infiltration. In another case, catheterization, after deviation of the urinary stream by the method described, yielded great quantities of putrid purulent material. No diminution in pain or tenesmus ensued. The patient died on the eighth day. The author agrees with Legueu and Papin that the operation is useless, especially in cases in which there is a mucopurulent secretion from the bladder which is filled with necrotic detritus.

[Ed. Note.—Last resort measures for extensive cancer of the bladder are usually fruitless. At best the improvement to be expected is short and hardly commensurate with the pain and suffering incident to the operation. In spite of the high mortality, transplantation of the ureters, followed by total extirpation of the bladder, is the only procedure thus far advocated that offers any chance for even temporary relief in this type of case. When operation or a series of operations of such magnitude are indicated, the malignancy is usually so widespread that hope of cure is abandoned, unless the surgeon is totally inconsiderate of operative mortality. A number of cases of complete resection of the bladder have recently been reported from Russian clinics by Federoff and Bystrow. In a series of 321 cases from the literature, the immediate mortality varied from 50 to 60 per cent. Federoff advocates a two-stage operation and an early radical operation.]

Deming [31] reports a case of tumor of the bladder in a boy aged 20 months. The tumor was curetted from the wall of the bladder. A second operation was performed four weeks later, and the patient died three weeks afterward. The majority of such tumors in infants originate in connective tissue. More than 50 per cent. of a compiled series of cases were sarcomas. Tumors of the bladder grow very rapidly in children, and recur readily. Deming treated the base of the tumor and the adjacent bladder mucosa thoroughly with diathermy after removing the greater part of the growth. Radium was applied at that time, but there was a recurrence six weeks later. A second resection with a good margin of apparently normal bladder was

31. Deming, C. L.: Primary Bladder Tumors in the First Decade of Life, Surg., Gynec. & Obst. **39**:432-442, 1924.

followed by massive doses of radium externally, but recurrence was not prevented. Deming suggests that a total cystectomy might be indicated in similar cases.

[ED. NOTE.—Primary tumors of the bladder in the first decade of life have been uncommon in our experience. The few we have seen have been largely of the connective tissue type described, and while we have attempted treatment in some instances, it is doubtful whether anything was accomplished. Besides these we have seen a few cases of benign tumors of the bladder in children; these were made up largely of blood vessels and were characterized by extreme bleeding. One patient bled to death before treatment was undertaken. In the others, the hemangioma was completely excised with permanent relief.

We are in doubt about the advisability of so radical a procedure as a total cystectomy in these malignant cases, because our experience with this sort of malignant tumor, in other more accessible regions, is that they usually recur very early, no matter how radical the operation or when it is undertaken.]

Bumpus [32] reviewed 527 cases of tumors of the bladder. In fifty-one untreated cases, the average duration of the disease, from the time of onset, was two and one-half years. Fulguration was carried out in eighty-four (15.9 per cent.) of the cases. Recurrence was common and, at times, necessitated repeated fulguration. Radium treatment alone or in conjunction with some other form of treatment was employed in 212 cases. Five of the thirty-four patients in whom radium alone was used died shortly after treatment. Thirteen of nineteen patients treated died; six are living, none more than three years. Sixteen patients were treated with radium and the cautery; four were given radium prior to a cautery operation, nine during the operation, and three subsequently. Six of the nine are dead, only one having lived more than one year. One of the living patients has lived seven years. Seventy-eight patients received radium, before, during, or after a cutting operation; sixty-two have been traced. Twenty-two (35 per cent.) are alive, on an average of from three to four years after operation. Two hundred forty patients had resection or excision. Twenty-seven (11.2 per cent.) died following operation. Fifty-three per cent. of the patients traced are alive. Ninety-one are dead, the majority dying in the first two years after operation.

[ED. NOTE.—Bumpus says, with regard to the prognosis of operation for tumors of the bladder, the most important fact is the degree of malignancy. Broders' method of determining the extent of cellular

32. Bumpus, H. C., Jr.: Modern Methods and Results of Treating Malignancy of the Bladder, J. A. M. A. **83**:1139-1142 (Oct. 11) 1924.

differentiation or degree of malignancy has given us a definite standard which is of decided prognostic value. Broders' original work was with epitheliomas of the skin, the removal of which was an operation carrying practically no mortality. Another factor enters in the determining of the prognosis following operations for tumors of the bladder, the operative mortality. A tumor of a low degree of malignancy may be very large and require extensive operative procedure, markedly increasing the risk of resection. On the other hand, the highly malignant flat epitheliomas of the bladder are small and localized and may be resected with comparative ease. If the patient recovers from the operation, the prognosis will depend directly on the degree of malignancy.]

Walther and Peacock [33] employed diathermy in a large number of cases. In eleven cases of tumor of the bladder, four patients were treated merely as a palliative measure. The other seven responded promptly to diathermy. The authors believe that surgical diathermy or electrocoagulation is superior to other methods of dealing with vesical neoplasms, tumors of the urethra and lesions of the external genitals.

Urinary Reflux.—Bumpus,[34] in a study of urinary reflux, reviewed 1,036 cystograms and found evidence of reflux in eighty-nine (8.59 per cent.). Contrary to what would be expected, in 527 cystograms of patients with prostatic hypertrophy, only 4.74 per cent. showed evidence of reflux. The close relationship between infection and urinary reflux is evident in the study of its occurrence in the various groups of urinary diseases. It occurs with tuberculosis in 38.88 per cent.; with resection of the bladder, in 33.33 per cent.; with pyelonephritis, in 18.96 per cent.; with stricture of the urethra, in 4.62 per cent.; with tumors, in 4.74 per cent., and with diverticula of the bladder, in 2.38 per cent. The greatest incidence is in cases of tuberculosis, which is an infection of renal origin. However, in this complaint, cystitis occurs early and may account for the occurrence of reflux. In the majority of the cases of this series, there was surprisingly little evidence of impaired renal function.

Urinary Control.—Joly [35] divides cases of retention of urine into those due to mechanical, nervous and reflex factors. He also points out that distinction should be made between patients with retention and those with and without overdistention. In impermeable strictures,

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33. Walther, H., and Peacock, C. L.: Diathermy in Urology, J. A. M. A. **83**:1142-1147 (Oct. 11) 1924.

34. Bumpus, H. C., Jr.: Urinary Reflux, J. Urology **12**:341-346, 1924.

35. Joly, J. S.: Treatment of Retention of Urine, Lancet **2**:896-897 (Oct. 20) 1923.

that is, those that are so tight that no urine can pass, very fine gum elastic filaforms should be passed and tied in; this allows the urine to trickle by. Later, dilation can be done. If an instrument cannot be passed, the patient should be put to bed, given an enema and 30 minims of tincture of opium. If no urine is passed, a filiform may be tried a second and third time, anesthesia being used if necessary. A urethretome guide may be passed and an internal urethrotomy be done. If patients with stricture develop retention following excesses of alcohol, a moderate sized bougie or a catheter may be passed. Further dilation should be postponed until after spontaneous micturition is established. Retention after instrumentation is usually of short duration. A foreign body impacted in the urethra and causing retention is almost invariably a calculus. Foreign bodies introduced from without almost always pass into the bladder. Retention due to prostatic abscess is relieved on evacuation of the abscess. In cases in which there is chronic overdistention of urine with overflow due to benign enlargement of the prostate, Joly warns against too rapid emptying of the bladder. The tumor in the bladder should not be allowed to fall more than 2.5 cm. daily. Once the bladder is emptied, it should not be allowed to refill. In such cases, a two-stage prostatectomy is indicated. Diuretic fluid should be given in large quantities.

Watson [36] found varying degrees of urinary incontinence in two thirds of 183 patients operated on by him for cystocele. He notes, however, that incontinence is found in some women in whom the cystocele is not marked or is entirely absent. Like Bonney, he believes that incontinence is not due to interference with the sphincter itself but to a sagging of the urethra and neck of the bladder from its normal position, due to the weakening of the musculofascial sheet that normally supports it. The damage to this support of the bladder usually takes place as a result of the obstetrician's attempting to save the perineum by restraining the sinciput and pushing the whole head forward before the occiput has come right underneath the pubic arch. Another causative factor is the pushing down of the anterior lip of the cervix by the head of the child, thus pulling the facial support away from the bladder. Watson describes in detail the operation by which this fascia is repaired. He was able to secure a perfect control of the urine in 65.7 per cent. of his cases, and great improvement in control in an additional 21.9 per cent.

[ED. NOTE.—We agree with Watson and Bonney that the incontinence following childbirth is not wholly due to interference with the sphincter itself but to a sagging of the urethra and floor of the bladder

36. Watson, B. P.: Imperfect Urinary Control Following Childbirth, and Its Surgical Control, Brit. M. J. **2**:566-568, 1924.

from its normal position. Most of the patients can be completely cured, and all of them will be definitely benefited by a plastic operation, such as that described by Watson, which restores the bladder to the normal position and narrows the urethral sphincter region. It can usually be demonstrated cystoscopically that, in these cases, there is a certain degree of relaxation of the control muscle. We believe that often, in operating on these patients, the tendency has been to separate tissue too widely, and to perform too extensive a plastic operation. A simple restoration to normal position and relationship restores the functions of the bladder.]

Bailey and Huddy [37] report 107 cases of extravasation of urine, from all causes, in the London Hospital between 1908 and 1922. In more than half the cases, the extravasation followed peri-urethral abscess. The latter are divided into three groups: (1) those in which a swelling has been present for a considerable time, but recently has increased in size and broken its confines; (2) those in which the patient, straining at micturition, experiences a "sudden bursting" in the perineum, and (3) those in which a perineal fistula has recently closed. The mortality in this series was 43 per cent. The principal causes were septicemia and uremia; frequently the two go hand in hand. Three types of treatment are suggested: multiple incisions only; multiple incisions combined with suprapubic cystotomy, and multiple incisions combined with perineal cystotomy. The authors prefer the last method and recommend relatively few incisions, but insist that they should be made large enough and deep enough to penetrate the limiting fascia.

[Ed. Note.—These patients, a considerable proportion of whom die from general sepsis following the local infection, would seem to be of the group that might be benefited by mercurochrome-220 soluble intravenously. Undoubtedly, intravenous medication has been employed too generally, and it is time to stop and ask ourselves what are its real merits and its serious consequences. We have used merchrochrome intravenously in nearly all types of sepsis, and believe that there are very definite indications and contraindications for its use. It has been of greatest value in the infected genito-urinary cases, and in many instances it has seemed to arrest an infection that might otherwise have proved fatal. It might be well worth trying in such cases of urinary extravasation as reported by Bailey and Huddy. Young has made another real contribution in bringing forth the value of mercurochrome in intravenous therapy.]

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37. Bailey, Hamilton; and Huddy, G. P. B.: Extravasation of Urine: with Especial Reference to Peri-Urethral Abscess, Brit. J. Surg. **12**:183-191 (July) 1924.

Hernia.—Carp [38] gives the following classification of bladder hernia: (1) intraperitoneal, in which the bladder is completely surrounded by a peritoneal sac; (2) paraperitoneal, in which the bladder is partially surrounded by a peritoneal sac, in some instances very small, and (3) extraperitoneal, in which the bladder has no relation to a peritoneal sac because there is none. Eggenlarger, in reviewing 110 cases of all types of bladder hernia, found that eighteen were recognized before operation, but nevertheless the bladder was opened five times. Of fifty-eight cases, thirty-five were recognized during operation. In the remaining cases, the bladder wall was injured. In nine cases, the opening was unnoticed, five becoming apparent after operation and four at postmortem. In 192 cases mentioned by Cheesman, the vesical wall was recognized and avoided during operation in only forty-seven. Carp reviews sixty-one cases; in thirteen the hernias were incarcerated and in forty-one free. In twenty-eight cases, the hernia was reduced, and, in fifteen cases in which the bladder was injured, it was repaired and the hernia reduced. In four cases, the diverticulum was tied off. The bladder was injured in 40 per cent. of all cases.

[Ed. Note.—Nearly all hernias of the bladder seem to be of the extraperitoneal variety. Occasionally, the bladder was partially or, more rarely, completely surrounded by a peritoneal sac; in most cases, it appeared to have been pulled on in such a way as to draw the peritoneum onto it. In a very few cases, we have found the bladder wall caught in a hernial sac. If care is taken to note the tissue as it is dissected away from the hernial sac, the muscular coat of the bladder will usually be recognized in time to prevent its being injured.]

PROSTATE

Joly [39] reviews the several theories of the mechanism of prostatic obstruction: (1) primary lesion in the musculature of the bladder, in which case the enlargement of the gland plays only a secondary part; (2) changes in the bladder sphincter, due either to irritation or to anatomic disturbance of the parts, produced by enlargement of the prostate; (3) mechanical obstruction due to the enlarged prostate (the middle lobe is supposed to play a prominent part in obstructing the urethra, Joly believes it plays only a comparatively insignificant rôle), and (4) two or more of the foregoing causes acting in conjunction with each other. Joly, not being satisfied with any of these explana-

38. Carp, Louis: Extraperitoneal Inguinal Hernia of the Bladder with Special Reference to the Rôle of Prevesical Fat, Surg., Gynec. & Obst. **39**:443-457, 1924.

39. Joly, J. S.: The Mechanism of Prostatic Obstruction, Proc. Roy. Soc. Med., Section on Urology **17**:13-20, 1924.

tions as such, concludes that the obstruction is explained by the projection of an enlarged gland into the bladder in the shape of a cone, and that there is pressure on this cone equally in all directions. Such pressure may be divided into two components, a vertical and a horizontal. The horizontal component is directed from all sides toward the upper part of the urethra at right angles to it. This explains why straining makes urination more difficult for patients with prostatic hypertrophy. In considering this theory, the author says that: (1) the urinary pressure acting on the intravesical projection of an enlarged prostate tends to constrict the urethra; (2) the height of the projection is more important in this respect than the size of its base; (3) when the bladder is full and the urinary pressure at its maximum, the intravesical projection is not so prominent as when it is empty; (4) residual urine is caused by the ascent of the intravesical projection during micturition, and when it reaches a certain height, the pressure constricts the urethra and prevents the bladder from completely emptying, and (5) the amount of obstruction does not depend on the size of the prostate but on the proportion that the height of the intravesical projection bears to the radius of its base.

Sarcoma.—Taschiro [40] reported a case of sarcoma of the prostate occurring in a man, aged 60. There was extensive metastasis to the spleen, bones, lungs, liver and also to the brain coverings. The tumor in the prostate was composed of a richly cellular structure that shaded off gradually into the prostate tissue. Clinically, this case resembled a large tumor of the spleen with metastasis to the lymph nodes. The patient had been sick only a short time, and when he died was having severe pain in the upper part of the abdomen, but few symptoms referable to the prostate. Sarcoma of the prostate is quite rare, especially in the latter years of life. Bettoni, in a fairly complete review of the literature in 1923, was able to find only forty-nine cases.

Tuberculosis.—MacKenzie and Seng [41] report a case of complete calcification of the prostate. The patient was a man, aged 53. He gave a history of intermittent swellings in the scrotum of two years' duration and eventually sinus formation. He had an obstruction in the prostatic urethra which could only be passed by a filiform bougie. The left side of the scrotum was swollen, red and tender; on the right side were several scars. The prostate was very hard. Roentgen-ray examination disclosed a dense shadow in the area of the prostate, of the size and contour of the normal prostate. The left epididymus

40. Taschiro, Nobunoni: Zur Lehre der Sarkome der Prostata, Ztschr. f. Urol. **18**:321-325, 1924.

41. MacKenzie, D. W., and Seng, M. I.: Tuberculosis and Calcification of the Prostate, Canad. M. A. J. **14**:912-914, 1924.

and testis were removed and proved to be tuberculous. The calculus in the prostate was removed suprapubically and had apparently completely replaced the prostate. It is thought that this case is one in which tuberculosis of the prostate was cured by the deposit of lime salts.

Prostatectomy.—Aschner [42] reports 277 ward cases of completed prostatectomy from the Mount Sinai Hospital. Twenty-eight (8.3 per cent.) patients died following operation. A total of forty-five patients with prostatic obstruction died in the hospital. Eleven had not been operated on; eight had had cystostomy only; three had had one-stage prostatectomy, and twenty had had two-stage prostatectomy. Of the fourteen patients not operated on, twelve died from uremia and two from cardiac trouble. Five of the eight patients with drainage died from uremia, one from pneumonia, one from pulmonary embolism, and one from hemorrhage. One of the patients on whom the one-stage operation was performed died from postoperative hemorrhage, one from pneumonia and one from cysto-ureteropyelonephritis. Of the twenty patients dying after two-stage operation, two apparently died from coronary artery closure. In three, bronchopneumonia precipitated a fatal uremia, while, in a fourth, there was also bilateral infection. Renal infection contributed to the cause of death of eight patients. Four patients died from the operation; in one, a perineal extravasation of urine occurred; in another, a rent was made in the floor of the bladder, and, in a third, the peritoneum was torn during the second stage of operation. Of the forty-four patients who had had one-stage prostatectomy, six had unusual postoperative hemorrhages. In one fatal case, excision of a wedge at the vesical neck was performed for contracture, besides the prostatectomy. Hemorrhage requiring repacking of the prostatic bed occurred in three others. One hemorrhage occurred a week after the suprapubic wound had healed; catheter drainage was effective. In the 233 cases of two-stage prostatectomy, there were thirteen instances of unusual bleeding. Transient moderate bleeding, relieved by pressure, occurred in five cases. In four, the bleeding was sufficiently acute to require reopening the bladder and repacking the prostatic bed. Hemorrhage was much more common after the one-stage than after the two-stage operations. Epididymo-orchitis occurred after the one-stage operation in 10 per cent. of cases. In the two-stage operations, it occurred before operation in ten cases, and after operation, in thirty-five. The urethral catheter seemed to be responsible in only nine of the entire group. In only two of 277 completed prostatectomies was there microscopic evidence of carcinoma.

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42. Aschner, P. W.: Observations upon Suprapubic Prostatectomy, J. Urology **12**:251-266, 1924.

Walker [43] believes that infection of the seminal vesicles may be the cause of persisting urinary infection following prostatectomy. In such cases, he advises a transvesical vesiculotomy or vesiculectomy. The transvesical approach is satisfactory since it does not harm the sphincter muscles. The patient is rendered sterile but not impotent by this method.

Walker's [44] personal experience amounts to 820 cases in which a suprapubic prostatectomy was performed for simple enlargement of the prostate. The death rate was 8.4 per cent. Postoperative distention may be very severe. Walker gives a purgative two days before operation and several days after, if it is indicated. He says that dental sepsis and intestinal fermentation are common causes of postoperative distention of the bowels, and that renal insufficiency and infection are the most common and fatal complications. Urinary obstruction produces interstitial nephritis which markedly lowers the renal function. Walker considers the urea concentration test and an estimation of the blood urea as the most satisfactory methods of determining the renal function in prostatic cases. In ordinary cases with no pronounced renal impairment and no severe infection, the two-stage is certainly not safer than the one-stage operation. In the average prepared case, hemorrhage is not more common in the one-stage operation, and no advantage from the cystotomy need be expected. Two-stage operations were performed in only sixty-three (7.6 per cent.) of the cases. The patients had chronic urinary retention, sepsis, or could be catheterized with difficulty or not at all. Walker considers the two-stage operation an attempt to repair the mistakes of earlier neglect or unskilful treatment. Following prostatectomy, all tags, folds of bladder mucous membrane and semidetached plaques of capsule or nodules of prostate are removed. A hemostatic stitch is introduced on each side of the neck of the cavity, and a continuous suture of fine catgut is put in from the right side around the posterior edge and finished on the left side. If necessary, the capsule is packed with iodoform gauze. Several factors contribute to the formation of sepsis. One is the finger enucleation by rectum, which Walker does not employ. Threads of mucous membrane and prostatic capsule necrose and form a culture ground for bacteria. In the open operation, these are removed. Stagnant urine and blood clots collect in the prostatic capsule; these are provided for by leaving a urethral catheter in place or by constant urethral irrigation. Persistent sepsis after operation may be due to

43. Walker, J. T.: Ueber transvesicale Vesiculo- und Vesiculektomie, Ztschr. f. urol. Chir. **16**:168, 1924.

44. Walker, J. T.: Views on Prostatectomy, Canad. M. A. J. **14**:787-796. 1924.

pyelonephritis, diverticulum of the bladder and seminal vesiculitis. In some cases, Walker has removed the seminal vesicles through the floor of the bladder.

[ED. NOTE.—Prostatectomy has always been attended with a mortality rate that seemed to be too high for the magnitude of the operation. This rate is constantly being lowered as a result of a better understanding of renal function, improvements in anesthesia and in technic. Specialization is recognized as of the greatest value in these cases. The difference in the mortality rate following operations by urologic surgeons and that of general surgeons suggests that specialized care and long continued preparation are of decided advantage to the patient. Deaver found 6.9 per cent. mortality in a compiled series of 4,654 cases of suprapubic prostatectomy. If all series of 100 cases or over were removed, thereby eliminating the work of the majority of urologic surgeons, the mortality immediately would rise to between 20 and 30 per cent. Whiteside, in 1905, noted a general mortality of 20 per cent. Ten years later, he reviewed the work of thirty-four surgeons, with data on 1,432 cases. About one-half the surgeons contributed 820 cases. These were men experienced in the removal of the prostate; the mortality in their cases was less than 3 per cent. In the remaining cases, the mortality was 26 per cent. Freyer reports a large series of cases with a 5.3 per cent. mortality. The mortality, in his cases, diminished from 10 per cent. in the first 100 cases to 3 per cent. in the last 200. Pauchet, who strongly advocates the two-stage operation, reported four series of 100 cases each. In the first 100 cases, ten patients died, eight died in the second series, six in the third, and only four in the fourth. He believes that the progressive improvement was due to improvement in operative technic, local anesthesia, and better preoperative and postoperative care. Many factors enter into the causes of death following prostatectomy. Old men stand hemorrhage poorly; infection is common, and bleeding greatly increases the risk of infection. If there is even mild urinary obstruction, there is a dilatation of the upper urinary tract, and, often, renal atrophy and infection.

Deaver compiled reports on 147 deaths following suprapubic prostatectomy; thirty-nine were due to uremia, thirty-two to hemorrhage, and thirteen to sepsis. Thirty-five were attributed to shock, asthenia and cardiac conditions. Freyer had fifty-seven deaths in 1,036 cases. Twenty-one were due to uremia and nine to cardiac trouble. Pauchet mentions infection, renal insufficiency and necrosis as important causes of death.

Patients dying following prostatectomy die of real causes. If a large percentage of necropsies are obtained, the number of deaths ascribed to shock, exhaustion and asthenia markedly diminishes.

Uremia is still the cause of a large number of postoperative deaths, but, in recent cases, owing to more accurate functional tests, sacral anesthesia and greater care in the selection and preoperative preparation, it is less common. Urinary infection is now apparently one of the most common causes of death following the removal of the prostate, causing about one third of all deaths. The most common type of infection is a cysto-ureteropyelonephritis. Many of these cases progress to the stage of phlegmonous cystitis, or multiple abscesses of the kidney. The deaths from general septicemia are closely allied and similar to those resulting from extensive urinary infection. In most cases, the generalized infection is a gangrenous cystitis or an ascending pyelonephritis. Practically, in all cases in which the urine is infected, or in which obstruction has been present for some time, there is more or less nephritis. In many cases, death is caused by an acute exacerbation of an old nephritis. Unquestionably, urinary infection and uremia are closely associated. Occasionally, in reviews of cases of prostatic obstruction, the tendency has been to ascribe death to uremia, if there has been a gradual suppression of urine, especially if necropsy has not been carried out. The intravenous use of mercurochrome-220 soluble in these cases of infection of the urinary tract, seems important, and we are hopeful of accomplishing a great deal in prostatic diseases.

Thrombosis and embolism, which frequently occur, are unavoidable causes of death following prostatectomy. The emboli usually lodge in the pulmonary arteries and are fatal. In an occasional case, the embolus is small and limited to one or more of the minor branches of the pulmonary arteries, and the patient may recover. In rare cases, a number of such attacks may be successfully combated. Myocarditis, coronary sclerosis and disease of the cardiac valves not uncommonly are found in men of prostatic age. Cardiac complications occur much more frequently after a general anesthesia than after the prostate has been removed under sacral anesthesia. Terminal bronchopneumonia is a very common finding in patients dying following prostatectomy, but only in a small number of cases is it the primary cause of death. Peritonitis may result either from opening the abdominal cavity with contamination of the peritoneum, or it may be one phase of general septicemia. Localized peritonitis may be caused by an extension of a severe perivesical infection or cystitis through the peritoneal covered area of the bladder.

Hemorrhage alone is responsible for only a small number of deaths, but it unquestionably is an important contributory factor in many deaths. Thomson-Walker notes that there were only two deaths from hemorrhage in 1,276 cases in St. Peters Hospital in London. On the other hand, he believes that many of the deaths attributed to shock, exhaustion

and cardiac diseases may be, in part, due to hemorrhage. Thomson-Walker's work in urology generally, and along this line especially, is very well known and greatly appreciated by all American urologists and many general surgeons. His idea of the technical steps of a prostatectomy has been very much in accord with ours. We have felt, for many years, that the operation of prostatectomy should be carried out with as much technical precision as any abdominal operation, and have developed our operation along those lines. This plan undoubtedly reduces the chance for infection and hemorrhage, which are the most serious complications, and, furthermore, it assures quicker healing, a more complete restoration of the bladder and, therefore, more satisfactory functional results.]

Stone.—Israel [45] reports a case operated on by Marion, who removed several stones from the bladder and prostatic urethra of a man, aged 67; one stone was free in the bladder and the second in the prostatic urethra. A third stone was enclosed in a diverticular sac that opened at the left base of the bladder, into which the urethra opened. This stone was about 2 cm. in diameter and formed a cast of the dilated prostatic urethra. Israel believes that the stone migrated from the bladder. In discussing urethral stones, Marion says that they form in two ways. They may be primarily renal or bladder stones that lodge in the urethra in an attempt at expulsion; they may be too large to pass through the open urethra, or they may be hindered from passing by one of the urethral structures. The second type of stones forms directly in the urethra behind some obstruction; their formation is favored by urinary infection and stagnation. Urethral stones may form in urethral pockets or, at times, in true urethroceles, which may appear to be entirely independent of the canal but which usually communicate with it by small openings. The urethral stone may be multiple, and occasionally faceted.

HEMATURIA

Gottlieb [46] reports thirty-six cases of hematuria associated with appendicitis. The cases are divided into those in which hematuria appeared with the onset of acute appendicitis, seven cases; those in which hematuria appeared after the onset of acute appendicitis, twelve cases; and those in which the hematuria appeared in cases of chronic appendicitis, nine cases. It is emphasized that the source of the hematuria is to be determined by cystoscopy. It has been found to be renal, ureteral, right-sided and left-sided, and at times bilateral. It may be gross or microscopic, and it may or may not be associated with pus. At

45. Israel, S.: A propos d'un cas de calcul de l'urètre prostatique, J. d'urol méd. et chir. **17**:475-479, 1924.

46. Gottlieb, J. G.: Zur Frage der Hämaturie bei Appendicitis, Ztschr. f. urol. Chir. **15**:30-49 (Feb.) 1924.

times there may be casts and albumin indicative of acute glomerulonephritis. A consideration of the theories to account for hematuria or renal involvement with acute and chronic appendicitis leads to a discussion of the proximity of the appendix to the right ureter, which might lead to ureteritis by direct extension of the inflammation, or extension of the inflammation by way of the anastomosis between the renal capsular veins and the mesenteric veins, or extension by way of the lymphatics, the spread of pus retrocecally into the pararenal tissues, or the spread from thrombi. A focal extension from the appendix to the kidneys with resultant acute glomerulonephritis is considered as probably the cause of the trouble in many cases. Infarction of the kidney from an infectious process that may arise in the appendix is also a possibility. In one of the cases mentioned, renal infarcts were found.

[Ed. Note.—Hematuria in cases of acute or chronic appendicitis is not common, but like pyuria, when present, it confuses the diagnosis and may lead to error. As in one of the cases mentioned by Gottlieb, acute appendicitis and pyonephrosis may be coexistent, and the therapeutic problem is to determine which shall be first attacked as the most prominent and important offender. Calculus in the right kidney or ureter also may exist. In Gottlieb's case, three shadows on the right side which were never completely accounted for, led to the removal of the kidney before the inflammatory condition of the appendix was recognized. Only after the appendix was removed did the symptoms subside. When hematuria is present, it is certainly advisable to carry out complete cystoscopic investigation in order to determine its origin and the function of the kidney. Gottlieb brings to our attention again the fact that such hematuria may be an incidental association or may be etiologically related to other more important acute or chronic lesions, such as appendicitis. In view of the fact that from 25 to 50 per cent. of patients with ureteral lesions have their appendix removed before consulting the urologist, it is interesting to know that conditions are sometimes reversed.]

ANESTHESIA IN UROLOGY

Lewis [47] describes his method of anesthetizing the urethra preparatory to manipulations of the ureter and bladder. He uses readily soluble tablets (1 grain, 0.06 gm., each) of either procain, alypin or cocain, which are deposited in the urethra at the desired point. If the male is to be examined by cystoscope, the point of election is the posterior urethra, just past the external sphincter. An ingenious urethral tablet depositor is used to place the anesthetic. The depositor with the

47. Lewis, Bransford: Local Anesthesia for the Urethra, J. Urology **12**: 527-533, 1924.

obturator is introduced to the desired point, the obturator is withdrawn, the tablet inserted into the funnel-shaped opening and pushed through the tube with the obturator. The tablet is permitted to dissolve in the mucus of the urethra for a half-minute or so and then moved around gently with the depositor.

Meeker and Scholl [48] review 1,817 cases of sacral anesthesia from the Mayo Clinic. Satisfactory anesthesia was not obtained in 5.3 per cent. of the cases. The highest percentage of failures occurred in cases in which extrapelvic structures, not supplied by sacral nerves, were encountered. Two hundred and seventy of 526 prostatectomies performed during the last three years were done under sacral anesthesia; nine (3.3 per cent.) died following operation. In contrast to this, 187 were done under spinal anesthesia, and sixty-nine under ether. Thirteen (6.95 per cent.) of the patients with spinal anesthesia, and five (7.24 per cent.) of those etherized died following operation. In sixteen (5.8 per cent.) of the prostatectomies, it was necessary to supplement the sacral anesthetic with a general anesthetic: ether, nitrous oxid or ethylene. In several of these cases, the general anesthesia was short and was employed more for the psychic than the anesthetic effect. Sacral anesthesia definitely eliminates the group of immediate deaths usually attributed to shock and cardiac disease. The success of sacral anesthesia in resection of the bladder depends mainly on the extent of the resection and the tissues involved in the malignancy. Sacral anesthesia, together with suprapubic field block, was employed in forty-two operations for carcinoma of the bladder. In thirty-two cases, the bladder was partially resected; in some of these, as much as one-half of the bladder was removed. Ether was required in three cases. Only one patient died following operation. Death occurred on the seventh day from pneumonia and multiple abscesses in the heart and kidney. There were eight cases in which a diverticulum of the bladder was resected. Ether was required in three. Sacral anesthesia was induced in 585 cases for urologic examination. Usually, a single caudal injection was sufficient for a complete cystoscopic examination. In cases in which this was insufficient and in all cutting operations, the lateral formina also were injected. Sacral anesthesia is usually very satisfactory in irritable, inflamed bladders, especially those primarily tuberculous. It also produces excellent relaxation of the lower ureter and permits the manipulation of ureteral stones.

Stirling [49] reports 168 cases in which spinal anesthesia was used for surgical procedures. He asserts that this method is indicated in all

48. Meeker, W. R., and Scholl, A. J.: Sacral Nerve Block Anesthesia, Ann. Surg. **80**:739-772, 1924.

49. Stirling, W. C.: Intradural Anesthesia in Genito-Urinary Surgery, J. Urology **12**:535-541, 1924.

genito-urinary operations especially below the umbilical region. He has employed spinal anesthesia for nephrectomies, prostatectomies and various urethral operations. Spinal anesthesia should not be used for patients with marked hypotension, unless measures are taken to combat a further drop in blood pressure. Patients with high arterial tension take it well, as do patients with heart lesions, as the heart is rested during the anesthesia. It is also well borne by patients with respiratory diseases requiring operative measures.

Lowsley and Rogers [50] report 117 urologic operations in which regional anesthesia was employed. Seventy-five perineal prostatectomies were performed under sacral anesthesia. Ten of the patients required some type of general anesthetic; seventy-one were cured and four died. Eleven operations on the kidney were performed under paravertebral anesthesia. Two patients required ether; one was fairly well anesthetized; the remainder were satisfactory. One patient died the day after operation. Six of the entire group died. The hemorrhage in cases of prostatectomy is surprisingly slight, and is considered as one of the greatest influences in the prevention of shock. The other is the patient's lack of pain after operation; the anesthesia persists from six to eight hours after injection, and therefore the element of pain is eliminated while the patient is recovering from the direct effects of his operation. One of the most important phases of regional anesthesia in urologic work is that the patient can take fluids up to, during, and immediately after operation.

[ED. NOTE.—Much controversy has existed between the exponents of sacral and spinal anesthesia. Rytina has used spinal anesthesia in over 500 cases without a death or a serious complication. Chute has performed about 400 prostatectomies under spinal anesthesia without a death at the time of operation or at any other time which could be attributed to the anesthetic. Chute has not found sacral anesthesia to be free from toxicity. Ehrich states that spinal anesthesia is not such a harmless procedure as is usually described by writers on the subject; when he injects the spinal canal, he feels that the patient has had a surgical operation. Gardner is very enthusiastic about spinal anesthesia. Bransford Lewis says:

> When the spinal anesthesia is good it is ideal, when it is not it is fatal, and that happens too many times. Therefore, I think the preference should go to the sacral anesthesia with no mortality rather than to the spinal with the high mortality.

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50. Lowsley, O. S., and Rogers, H. E.: One Hundred and Seventeen Consecutive Major Urologic Operations Performed Under Regional Anesthesia, J. Urology **12**:543-556, 1924.

Spinal anesthesia has been in use by a large number of surgeons for many years; it is a simple procedure and has many exponents. Sacral anesthesia is a comparatively new method. It has been used spasmodically for from ten to fifteen years, particularly by continental gynecologists and urologists. At first consideration it appears to be technically a more difficult procedure than spinal. Sacral nerve blocking up to the present time has only a few ardent advocates, its facility of induction, its satisfactory anesthesia and its freedom from toxic effects have not been generally recognized.

Davis says:

> Considering the age and debility of the average candidate for prostatectomy, it is in this procedure that the employment of any method tending to lessen the shock of the operation becomes doubly urgent. For the operation of prostatectomy, sacral anesthesia is ideally suited.

Schmidt says:

> There can be no question that in the hands of those who are qualified, perfect anesthesia for perineal operations is obtained by both the epidural and the parasacral methods. I prefer the former, and have seen no untoward results from either method; however, failures occur in both. The intraspinal method unquestionably, if given sufficiently high, gives perfect anesthesia, but I maintain that there may be alarming sequelae. As to my own statistics, I believe that, all in all, the sacral methods are safer and in conjunction with infiltration anesthesia, when suprapubic work is done, that it is the method of choice.

Syms believes that sacral anesthesia is one of the greatest added factors in prostatectomy. He has been doing all his perineal and rectal work under sacral anesthesia since 1918. He believes that spinal anesthesia is too dangerous for promiscuous use. Young has employed sacral anesthesia for over thirty prostatectomies, for several radical excisions of tuberculous seminal vesicles and prostate, and for one radical excision of a carcinoma of the prostate with the neck of the bladder and seminal vesicles. He uses the single caudal injection; when the upper portion of the seminal vesicles and the vasa differentia are attacked, he injects procain locally. Young has found the method satisfactory, and asserts that it is simpler and safer than spinal anesthesia and gives perfect results in practically all operations on the perineum. Crowell has been using it entirely for prostatectomies during the last three years, and finds it an ideal anesthesia for perineal prostatectomy. When both sacral and spinal anesthetics are given by experts, the percentage of failures is practically the same. Sixteen (5.8 per cent. of 270) of Meeker's sacral anesthesias for prostatectomy were failures. A certain number of patients object to being awake during the operation and demand a general anesthetic. These cases must necessarily be included

with the group of either partial or complete failures. The 5.8 per cent probably represents the minimum of failures in this type of case. A similar percentage representing the group of actual failures of the anesthetic and cases in which general anesthetic was demanded is found in operations performed under spinal anesthesia. In eleven (6.5 per cent.) of 167 prostatectomies performed at the Mayo Clinic under spinal anesthesia, a general anesthetic was required for completion of the operation. Spinal and general anesthesia have been practically abandoned in favor of sacral anesthesia at the Mayo Clinic during the last two years. The operative and postoperative periods are smoother, the number of complications are less, and most important of all, the operative mortality is less than half of that following either spinal or ether anesthesia. Spinal anesthesia is considered dangerous usually on account of the cardiovascular or respiratory disturbances that may appear shortly after induction. Weizeld noted four cases of injury to the spinal cord resulting in an extensive paralysis. One patient, who was paralyzed fourteen weeks after the anesthesia, recovered. A second patient, who was paralyzed twenty-seven months after intraspinal anesthesia, died.

CORRECTION

An error occurred in the transcript of Dr. Eloesser's discussion of Dr. Archibald's paper in the supplement to the January issue, p. 349. The first line of the second paragraph should have read: "My statistics are: Twenty Sauerbruch operations were performed on sixteen patients."